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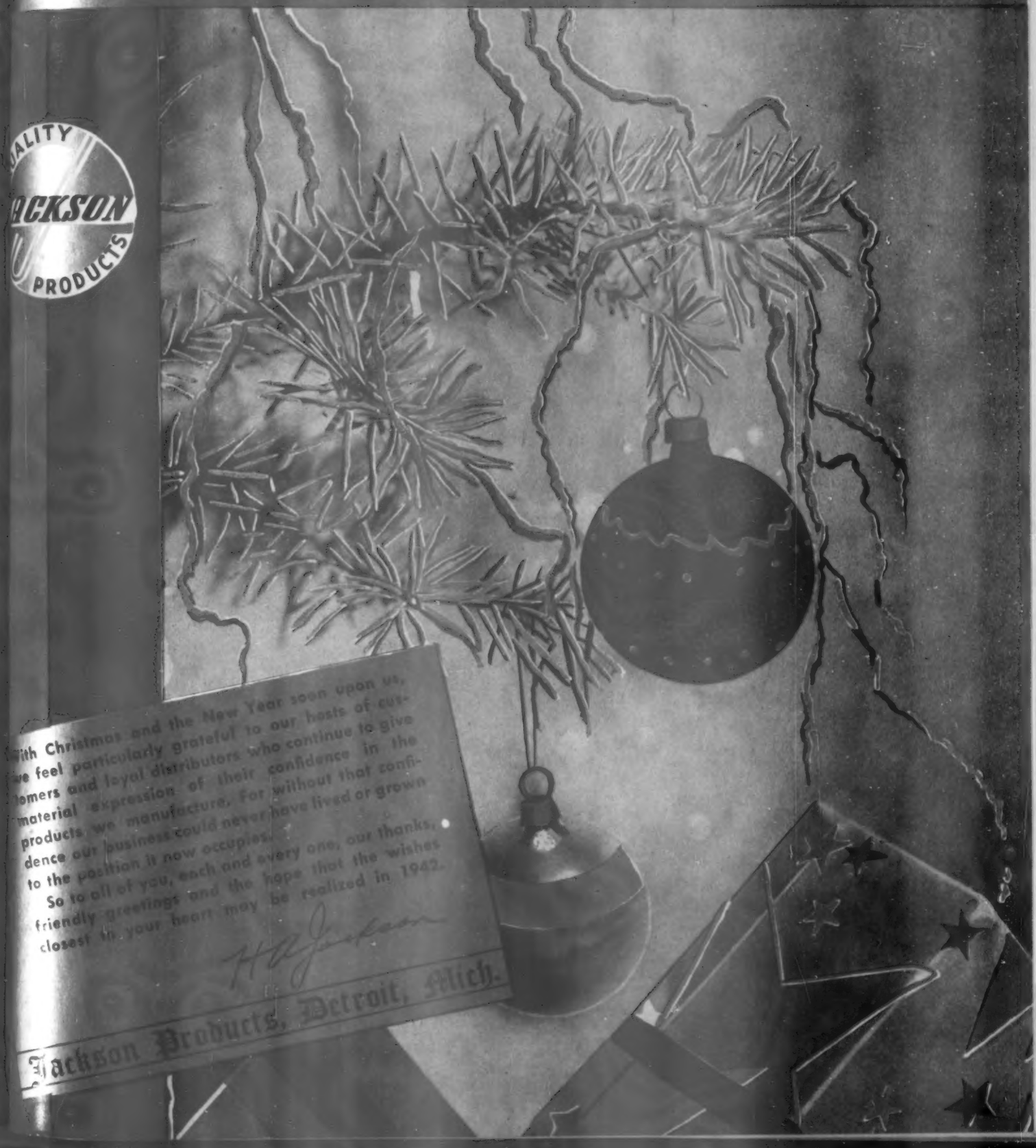
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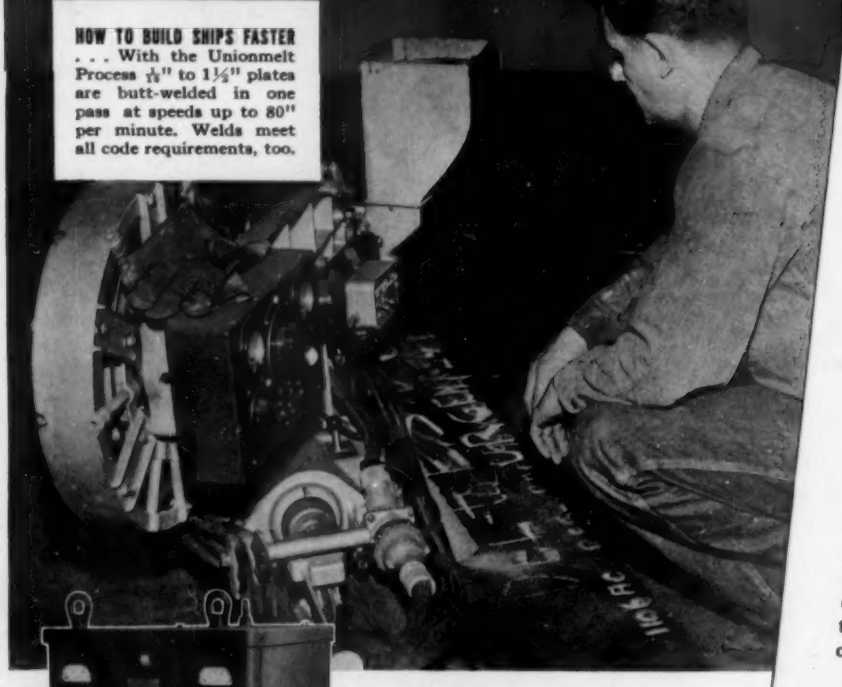

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WESTINGHOUSE

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Eastern Representative:
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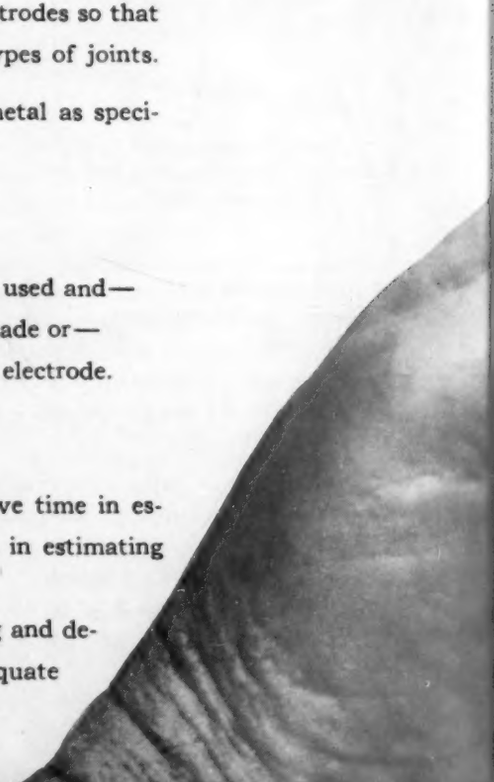

GENERAL ELECTRIC

By **A. J. MOSES**
General Manager
Hedges-Walsh-Weidner Div.
Combustion Engineering Co.
Chattanooga, Tenn.

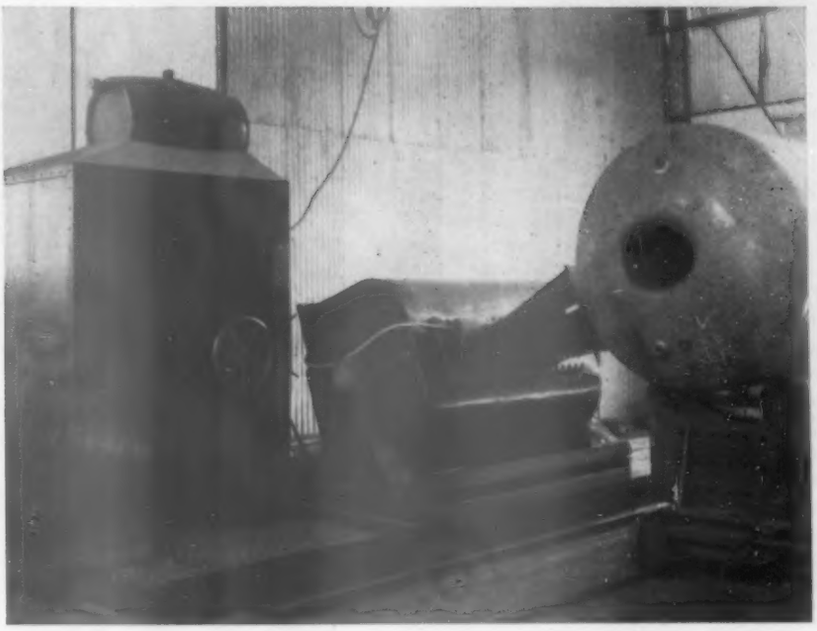

Fig. 1—An early day 300,000 v. oil-immersed X-ray unit.

X-Raying Welded Pressure Vessels*

In this review of ten years progress in the radiographing of welded pressure vessels there is described the advantages in time, sensitivity and penetration of million volt X-ray equipment when examining seams in welded vessels.

THE development and improvement of industrial X-ray apparatus has been a major factor in the progress made in the manufacture of fusion welded, heavy wall, pressure vessels. The improvements made in such X-ray apparatus during the past ten years have surpassed expectations. The improvements in sensitivity of this non-destructive test and the reduction in time required for making such test have been rather startling. A few years ago we were forced to painstaking technique and to cumbersome aids, in order to make sure that radiographs would disclose cracks of the order of ½ in. in depth, in 4 in. thickness welds. Today we can detect cracks ⅛ in. in depth, in 6 in. thickness welds. Until two months ago it was requiring 7½ hrs. to take an X-ray picture of 12 lin. in., of 5⅜ in. thickness welds. Today, 24 lin. in. of such thickness welds are being taken in 15 min.—a reduction in time of 60 to 1.

Before discussing the last major improvement in industrial X-ray apparatus, a development of the first magnitude, it might be well to review briefly the history of the application of the X-ray test to welded pressure vessels during the past 10 years. The welding of heavy wall vessels is a hazardous venture and considered unsafe in the absence of a reliable non-destructive test. The X-ray was accepted as a reliable test for such welding, in the boiler industry, ten years ago. At that time, which was just prior to the acceptance of fusion welding in the manufacture of boiler drums by the American Society of Mechanical Engineers Boiler Code Committee, the Combustion Engineering Co. purchased a 2-tube, 200,000 v. air cooled outfit. At that time we were very much pleased with the equipment. No one had had much experience in the X-raying of extremely heavy plate thicknesses, and, for the average thicknesses we were encountering at that time, this X-ray equipment was very satisfactory.

At that time we were dealing with weld thicknesses from ½ in. to 2½ in., but the demand for greater thicknesses was increasing all the time. From the experience gained in making repairs in light and heavy welds, we soon came to the realization that this equipment had serious limitations as regards reliable sensitivity and reasonable exposure time, in the heavier plate ranges. Practically all of the X-ray pictures of welds over 2 in. in thickness were showing up as perfect welds, which was not at all reasonable.

At that time the General Electric X-Ray Corp. was preparing to bring out its 300,000 v. industrial unit. In fact, they had manufactured several

*A paper presented Oct. 7 at the General Electric X-ray symposium, Schenectady, N. Y.

of these air-cooled units. However, these were to be quickly superseded by a 300,000 v. oil-immersed apparatus. During this time, in the light of our experience, we were questioning whether higher voltages would help the situation much, unless better radiographs could be obtained. The manufacturer was advised of our experiences and fears, as regards the sensitivity in X-raying heavy plates. Thereupon, we jointly undertook a thorough investigation of the matter, which required many months. In the meantime, on thicknesses over 2 in., we established the practice of double X-raying—once with the weld metal at an interstage thickness, at which we could be sure of detecting important defects with the X-ray apparatus available, and secondly we X-rayed after the welding was completed, with the hope of detecting any gross defects that might arise or occur subsequent to the first X-raying. This procedure was most laborious and expensive.

The Bucky Grid

A 300,000 v. machine, the second machine purchased (Fig. 1.), was an oil-immersed outfit requiring much less space when compared to the first air-cooled tubes. While this machine has permitted the X-raying of thicker plates, it demonstrated no improvement in sensitivity. As a matter of fact, it was slightly less sensitive than the older 200,000 v. unit, within comparable plate thickness range, due to the use of a larger focal spot. However, the investigation we had been carrying along, in collaboration with the manufacturer, began to bear some fruit. After considerable experimentation with lead screens and other ideas, the G. E. Company brought out an adaptation of the Bucky grid, which, in a sense, saved the day for those of us who were deeply concerned as to the reliability of X-raying heavy welds. With the aid of the industrial bucky, we found that we could depend on the X-ray test, up to 4 in. thickness plate; but, the time of exposure on this thickness, using the bucky and the 300,000 v. tube, was excessive.

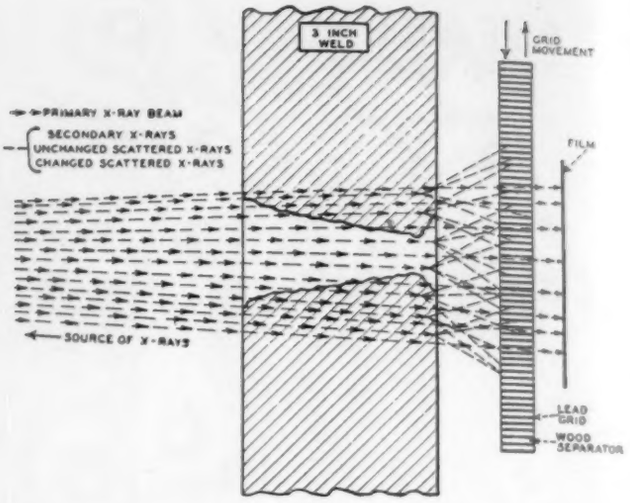

Fig. 2—A diagram showing the workings of the Bucky diaphragm.

We began immediately to use this bucky on welds 2½ in. in thickness, and over; and subsequently, required its use on welds 2 in. in thickness, and over. A schematic diagram of the functions of this bucky is shown in Fig. 2. I believe that the development at that time, of this aid, was as startling and encouraging to us as the recent development of the 1,000,000 v. tube is today. The bucky pushed back our frontiers at that time, the upper picture shows a very serious crack in a 3 in. weld, without the aid of the bucky; and the lower showing the same with the aid of the bucky. While this crack was so serious that it could be easily perceived on the negative taken without the bucky, the difference in clearness between the two pictures was indicative of the fact that perhaps numerous cracks of a lesser order could occur which could not be detected without the bucky.

A 400,000 v. X-ray Unit

In Fig. 3 is shown the bucky in position for taking a picture in a longitudinal weld seam. Incidentally, Fig. 3 also shows the third X-ray apparatus we purchased—a 400,000 v. oil-immersed outfit. As helpful as it was in improving the reliability of the X-ray test, the bucky was cumbersome and a great time consumer, in that the time of exposure with this grid was some six times longer than without it. From the time-thickness curve for the 300,000 v. tube, with the bucky (Fig. 4), it will be noted that, as plate thickness increases beyond 4 in., the time of exposure approaches infinity. This clearly demonstrated the need for higher voltage equipment, not alone to save time in lesser thicknesses, but to permit us to fabricate welded boiler drums above 4 in. in thickness.

The next development by the G. E. X-Ray Corp. was a 400,000 v. oil-immersed outfit, which is pictured in part with the Bucky in Fig. 3. You will note from these curves (Fig. 5), which were plotted from our earliest data, that the 400,000 v. machine lifted our limit to 5 in. thickness material. In Fig. 5 is shown later curves that have been plotted for the 400,000 v. machine alone.

We have been limited, now, for several years, to about 5 in. in thickness; however, there have been demands for boiler drums of thickness of 6½ in. or more, in the past. Due to the limitation of the X-ray test, we have in such cases been forced to go to very expensive, solid, seamless forgings. At present, the forging capacity of the country is so taken up that we are being forced to weld greater thicknesses than heretofore attempted. This year some boiler drums 5¼ in. to 5⅜ in. in thickness have been fabricated. With our 400,000 v. machine and the use of the bucky, it required 7½ hrs. to take individual pictures of these weld seams. Therefore, it can be appreciated why the development of the 1,000,000 v. tube, which will take pictures of such thicknesses in 15

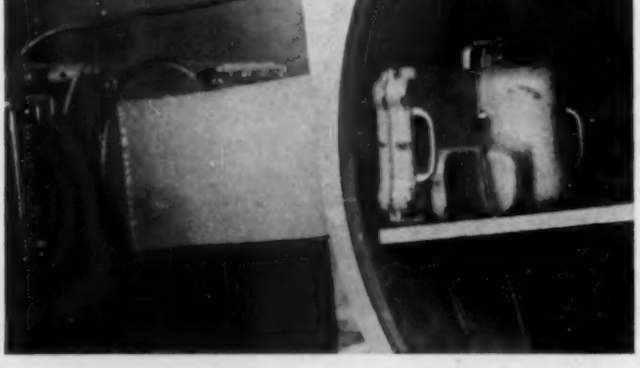

Fig. 3—A view showing the Bucky when taking a picture of a longitudinal weld with 400,000 v. machine.

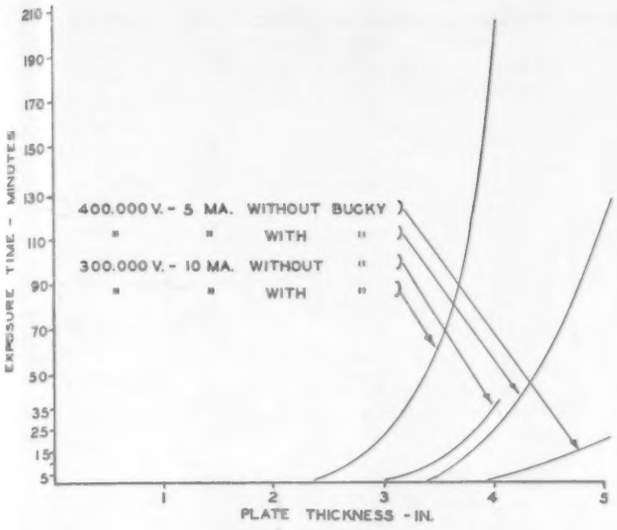

Fig. 4 — Exposure-time curves for 300,000 v. and 400,000 v. machine for various plate thicknesses.

minutes is viewed as progress of the first magnitude.

The Million Volt Machine

I will not go into the technical details of this million-volt machine. I can only tell you something from our limited experience with this apparatus in our application. We have had the apparatus such a short time that it has not been possible to work out the niceties as regards procedure and technique. Fig. 6 shows the X-ray tank and tube suspended over a boiler drum in the X-ray room. I might explain that the unit is assembled in a cradle, which is carried by an overhead crane. It can be traversed in three directions, by means of the overhead crane, and can be rotated on trunnions in the cradle from the vertical to the horizontal position. The equipment is housed in a room 21 ft. wide and 60 ft. long. This room is surrounded with 18 in. thick concrete walls, carried to sufficient height to insure protection to all personnel. The control equipment is located in an anteroom connected with the main X-ray room by a concrete maze. The control room and adjacent dark room are further protected with additional lead. Large, concrete, rolling doors admit motor-driven trucks, carrying the work into the main X-ray room. Power cannot be thrown on the X-ray tube until these doors are closed.

In the view shown, the X-ray tube is shown located for taking a picture of the longitudinal weld seam. All that remains to be done in taking this picture is lifting the apparatus to the proper focal film distance height. Films 32 in. long are used at present in the X-raying of such longitudinal seams. Ample head room is provided, such that even longer pictures may be taken, if it develops that such is feasible. At the present time we are continuing with experiments along this line, together with other experiments to determine the desirable thickness of lead screen and the

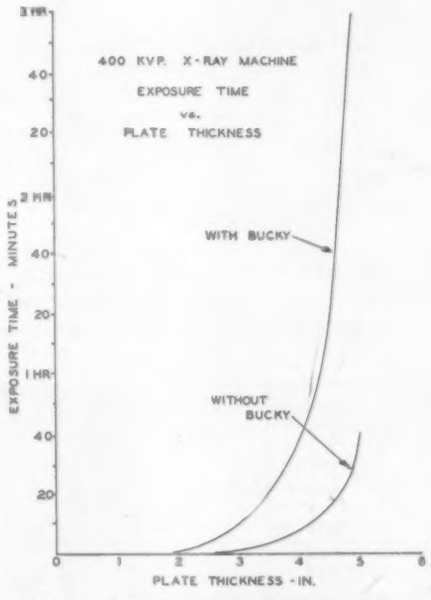

Fig. 5—Detailed exposure-time curve for 400,000 v. machine.

quantity of lead shielding necessary. With the million-volt machine, intensifying screens and the bucky diaphragm have been found unnecessary. Much work yet remains to be done regarding these matters, type of films, etc., before we can establish the most desirable procedures and technique.

The assembled X-ray unit may be rotated into a horizontal position and inserted through the man-hole of a boiler drum for the radiographing of the circumferential weld seam between the boiler drum head and the shell. A close-up of the positioning of the tube for this operation and a view of the cradle from which the X-ray unit is suspended is shown in Fig. 8. Heretofore, this method of radiographing girth seams has only been permissible in connection with the use of radium. Our old X-ray apparatus restricted us to very short, individual pictures, when radiographing circumferential seams. With the new apparatus films are positioned all around the girth seam and the complete seam is taken with one exposure.

A sketch, Fig. 9, shows the positioning of the X-ray tube and target for such girth seam X-raying. So far results indicate that the maximum radiation is obtained through the weld when the anode is displaced some 8 to 13 deg. out of the plane of the weld. Further experimentation may develop that differential screening can be used, so that the anode can be placed in the plane of the weld.

Exposure Time Data

As mentioned before, one of the most startling things about this apparatus is the time saving over old equipment. Fig. 7 gives a semi-logarithmic graph, with curves showing exposure time for various thicknesses, for both the 400 Kvp. and the 1000 Kvp. machines. It will be noted from these graphs that the 400 Kvp. performance is based on a 32 in. focal distance, and that the 1000 Kvp. performance is based on 60 in., 48 in., 36 in., and 32 in. focal distance. From this graph you will further notice that the 1000 Kvp. tube affords not only quicker exposure time, but a much better ratio as regards the focal-work and the work-film distance. From work done by Dr. Lester at Watertown Arsenal, he obtained optimum results with what he called the D/T ratio of 20. He has further

Fig. 6—The 1,000,000 x-ray head in position for a long seam shot. It is not set for proper focal film distance.

recommended that this ratio be maintained at a minimum of 10. With the old industrial X-ray equipment, it was impractical to live up to any such minimum ratio as Dr. Lester has recommended. With the 1000-Kvp. tube, more desirable ratios can be used. Table I shows a tabulation of the approximate technique for 1000 Kvp. industrial X-ray unit, for thicknesses varying from 1⅛ in. to 7 in., and for focal distances of 60 in., 48 in., 36 in., and 32 in. This technique is based on using ¼ in. lead filter between the film and cassette, and on single film viewing. It is known that improvements can be made by using double films, but we have not yet developed full information concerning this procedure.

Were we not taking advantage of the opportunity to use a better D/T ratio with the 1000 Kvp. machine, its performance as regards time of exposure, as compared to that of the 400 Kvp., would be more striking. Table II contains comparisons for equivalent focal distances of technique on the 400 Kvp. machine and the 1000 Kvp. machine, at thicknesses varying from 1 in. to 5¼ in. You will note that, using the same focal distance of 32 in. on both machines, in the case of 5¼ in. thickness metal the time of exposure required with the 1000 Kvp. machine is less than 1% of the time of exposure required with the 400 Kvp. machine.

Table I—Approximate Settings for Million Volt X-Ray Unit*

Thickness Plate, In.	Peak Kilovolts	Milli-Amperes	Minutes for Respective Focal Distance			
			60 in.	48 in.	36 in.	32 in.
1⅛"	890	0.5	1.00	——	——	——
1½"	890	0.5	1.50	——	——	——
2⅛"	950	1.5	1.50	1.00	——	——
2½"	950	1.5	2.75	1.75	1.00	——
3⅛"	950	1.5	5.00	3.20	1.80	1.25
3½"	950	1.5	6.50	4.20	2.30	1.60
4½"	1000	3.0	6.00	4.00	2.10	1.70
5"	1000	3.0	11.00	7.00	4.00	3.00
5½"	1000	3.0	18.00	12.00	7.00	5.10
6"	1000	3.0	35.00	21.00	11.00	9.00
6½"	1000	3.0	58.00	37.00	20.00	16.00
7"	1000	3.0	100.00	68.00	35.00	27.00

*Single film viewing; ¼ in. lead filter between film and cassette.

Table II—Comparative Settings and Time for Radiography

Thickness Plate	Machine	K.V.P.	Ma.	Focal Distance	Time Min.
1"	400 K.V.P.	170	5.0	42"	0.33
	1000 K.V.P.	890	0.5	42"	0.49
2"	400 K.V.P.	260	5.0	36"	1.25
	1000 K.V.P.	950	1.5	36"	0.54
3"	400 K.V.P.	367	5.0	32"	5.00
	1000 K.V.P.	950	1.5	32"	1.40
4"	400 K.V.P.	400	5.0	32"	35.00
	1000 K.V.P.	1000	3.0	32"	1.00
5"	400 K.V.P.	400	5.0	32"	270.00
	1000 K.V.P.	1000	3.0	32"	3.00
5¼"	400 K.V.P.	400	5.0	32"	450.00
	1000 K.V.P.	1000	3.0	32"	4.00

Aside from the saving in time, the new machine is much more sensitive, in detecting small defects in heavy plates, than was the case with equipment heretofore available. To demonstrate this, we have made a number

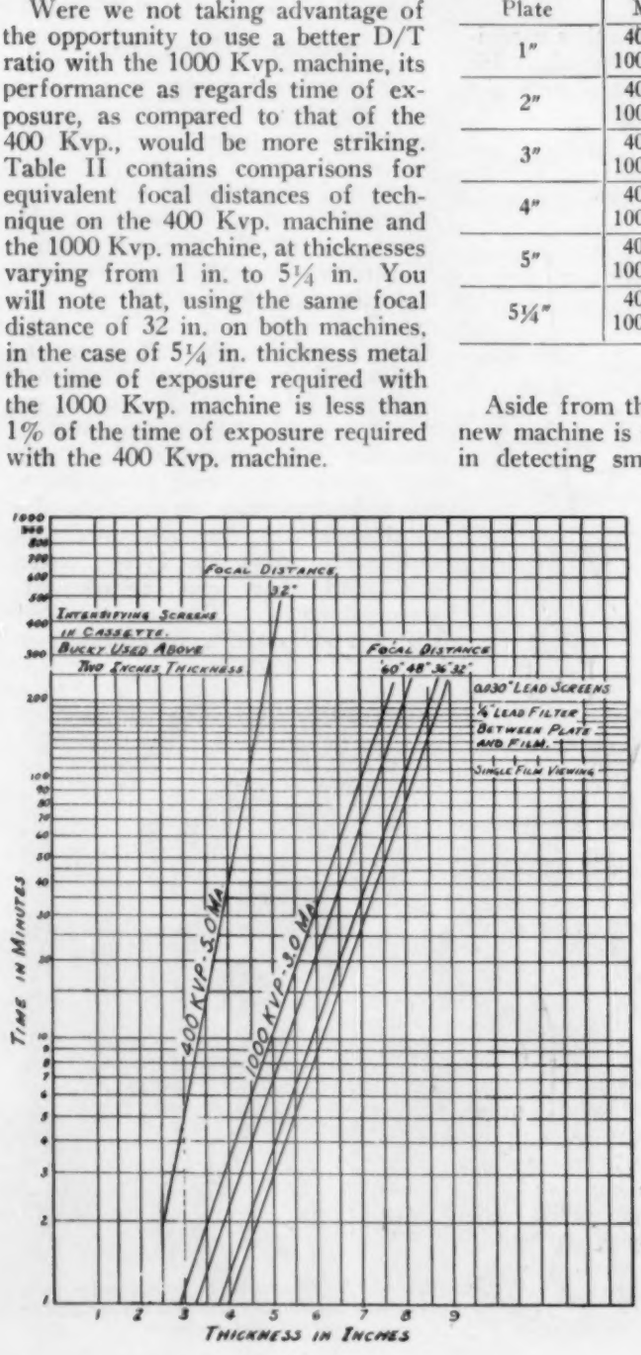

Fig. 7—Exposure-Time curves for 400,000 v. and 1,000,000 v. units for various thicknesses and focal distances.

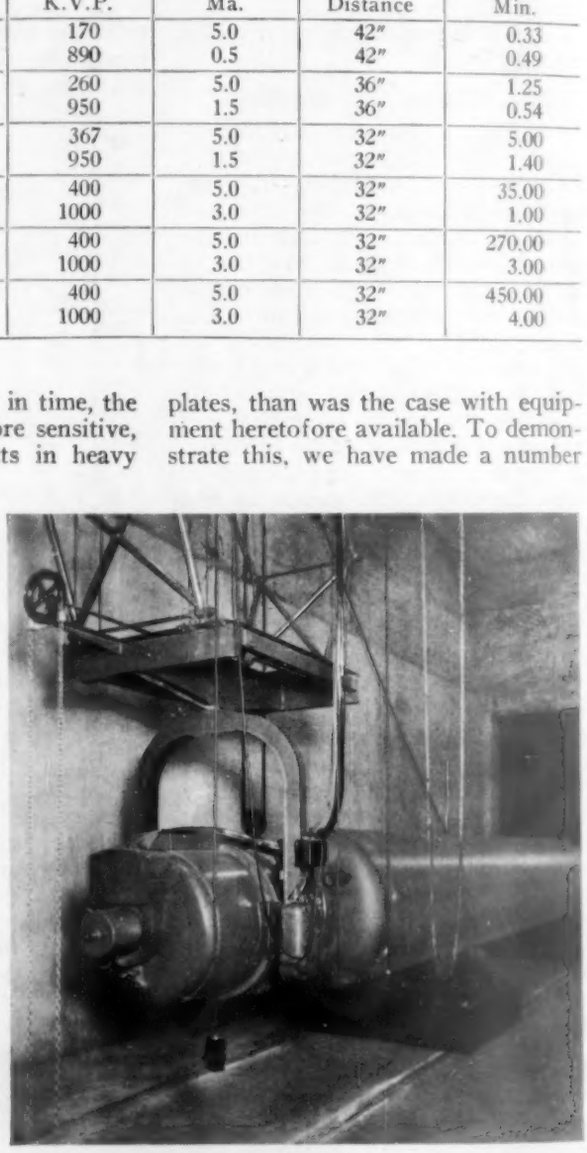

Fig. 8—A close-up of a 1,000,000 v. x-ray in position for a girth seam shot.

of radiographs of a wedge test block which was developed at the Watertown Arsenal. This wedge test block consists of two steel wedges 3 in. wide and 6 in. long, nested together so as to give parallel outside surfaces. One of these wedges varies in thickness from 9/32 in. on one end to 0 in. on the other. In this wedge there are two rows of small holes, drilled on ½ in. centers, using a #50 drill (.07 in. dia.). Also, extending for the full length of the wedge, are two artificial cracks, varying in depth from 9/32 in. to 0 in. In the experiments we made with this test block, we spread the cracks to a uniform width of .015 in.

In a test series exposures were taken of this wedge test block, both with the 400 Kvp. machine with the bucky and with the 1000 Kvp. machine without the bucky. These were taken at various thicknesses, the thickness being built up with solid, steel plate, and the wedge always being placed on the side remote from the film. These tests clearly show that the sensitivity of the 1000 Kvp. machine at 6¼ in. thickness of plate is equal to the sensitivity of the 400 Kvp. machine with the bucky at less than 5 in. thickness. With further study and improvement in technique, there is little doubt but what this improvement will show up at even greater thicknesses. The sensitivity of the new equipment as compared to the old was the basis for more tests with the use of another type of test block, developed at the Watertown Arsenal. This test block consists of a thin sheet of steel, ⅛ in. in thickness, in which there is a hairline crack of unknown, but varying depth. This type of fine defect constitutes a much more severe test than does the wedge test block. The crack was clearly shown with both old and new equipment, up to 3⅛ in. in thickness; but, in the case of the 400 Kvp. machine and the bucky grid, it was necessary to orient the grid line at an angle with the known direction of the crack. At 4⅛ in. in thickness, the crack is still discernible but beyond that thickness it is definitely lost.

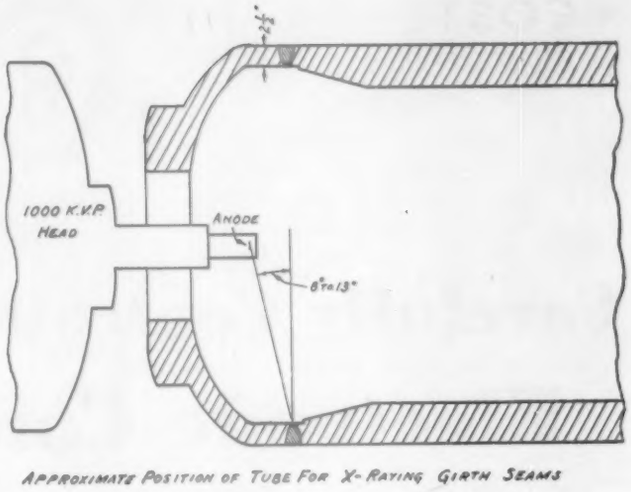

Fig. 9—A sketch showing location of x-ray tube for girth seam shot.

There is little probability of much greater improvement in sensitivity, with the 400 Kvp. machine and the bucky grid. There is still room for much improvement in technique with the 1000 Kvp. machine, as the study of the proper use of this equipment was begun only a few short weeks ago. The evidence already available indicates, without reservation, that the development of this 1000 Kvp. tube is an advancement of the first magnitude. For the welded pressure vessel industry, this testing equipment pushes back our frontiers beyond horizons we hardly expected to reach a few short years ago.

Metal Transfer in the Metallic Arc

By L. J. LARSON*

★ Speculation as to the forces which cause the metal to pass from the electrode to the work probably dates back to the discovery of the process, but judging from the recent literature on the subject there is still great diversity of opinion as to the driving force in the arc.

Among the forces suggested are: 1. Vaporization and Condensation; 2. Gravity; 3. Pinch Effect; 4. Electrostatic Forces; 5. Electric Effects; 6. Surface Tension; 7. Gas Stream from Weld rod Coatings; 8. Pressure on the Cathode Spot of the Arc; and 9. Expansion of Gases in the Metal at the Electrode tip.

Some of these differences in opinion may be due to the interpretation of "metal transfer." In the welding process the metal must first be "transferred" from electrode to work and then retained in position. To hold the molten metal in place surface tension is no doubt the most important force for all welding except in the downhand position. In flat welding surface tension is aided by gravity. The present discussion will not deal with the forces which retain the molten metal in place but with the forces which cause the metal to move from the electrode to the work and the term "metal transfer" is limited to this phenomenon.

A true theory of metal transfer must be consistent with the observed facts. Such a theory should explain why the metal moves across the arc space and in which direction it moves for every condition of welding for which metal transfer occurs. It is not logical to assume different theories for different welding conditions.

A study of the results published by other investigators shows:

(1) that a measurable force exists in the arc as evidenced by the reaction against the electrode and the pressure of the arc stream against the work.

(2) that most of the metal passes across arc space as liquid globules and not as vapor.

(3) that with a pure iron, degasified electrode overhead welding is impossible.

In addition, results published by the writer show that with a heavily coated, cellulosic type of electrode, operated on reverse polarity, the metal is transferred across the arc space in a stream of particles, most of which are .010 inches or less in diameter, moving at a speed ranging from 4 feet to over 100 feet per second. Similar action for representative bare and covered electrodes operated on both polarities direct current and on alternating current is shown by additional tests presented herewith.

An analysis of the various theories advanced shows that forces 1-8 fail to explain the action in the arc. Some of these assumed forces cannot produce a reaction against the electrode or account for the supply of particles found in the arc stream. Others fail to explain "metal transfer" because the transfer occurs without their aid or even against the assumed forces.

Of all the forces suggested as being responsible for "metal transfer" only one, the expansion of gases in the electrode tip, is consistent with observed facts. This force does account for (1) the reaction against the electrode, and (2) the stream of small particles always moving at high velocities from the electrode to the work with all commercial types of electrodes operated on all kinds of current. It also explains the inability to weld overhead with a pure iron degasified electrode. It is therefore concluded that gases in the tip of the electrode furnish the primary driving force of the arc and all others are contributory forces operative only under certain conditions.

*Consulting Engineer.
Presented at 22nd Annual A.W.S. Meeting, Philadelphia, Oct. 20-24, 1941.

Carefully Controlled Electrode Comparison Tests are Profitable

WALTER J. BROOKING,
Testing and Research Dept., R. G. Le Tourneau, Inc., Peoria, Ill.

In Parts 1 (October) and 2 (November) the author discussed the preliminary tests and observations to be made in determining the differences in welds made by different electrodes under the same conditions. In the discussion to follow, relative costs are determined to conclude this series.

Part 3—The cost per pound of the electrode is not nearly so important as the cost per pound of the deposited weld metal. A method for obtaining these costs in comparing electrodes is given.

Upon having determined various characteristics about electrodes by test the next step is the calculating the cost of electrode, of power, and of labor from the data of the test and the determination of the relative cost per pound of metal deposited and inches of weld per pound of purchased electrode. (The data of the test gives only arc time, so the deposition cost involving labor is only relative. The cost per pound of electrode deposited derived from these data does not include the operation factor—i.e. the relative amount of the time the operator is actually burning electrodes compared to the total time used for a normal job in the shop—and since overhead is usually charged on the basis of labor, no overhead is calculated in the relative deposition costs for the test).

Figures 11 and 12 show an example of the forms used for recording data for these comparative tests and also show an example of two electrodes actually compared. These two electrodes were both the downhand type of electrode designed for positioned welding or downhand fillet welding. The price per pound of electrode was the same for both and the general appearance of the electrodes and general performance so far as handling characteristics seemed to be about the same.

Efficiency Differences

The careful measurements of the test brought out some differences which, when taken individually did not amount to a great difference, but when they were added together as a group of separate small differences, they amounted to a total difference of 16.5% in the efficiency of electrode "A" over electrode "B".

The difference in the number of lineal inches of a standard weld per unit quantity of electrode was the greatest difference between the two, and also happened to be the most easily measured difference. The difference in power looked really quite small, but when it was compared in the light of the percentage of the electrodes deposited (deposition efficiency) it amounted to a large difference. The burnoff rates per electrode varied only a small amount between the two samples.

The magnitude of such a group of small differences as shown by the above comparative test of two electrodes from a cost standpoint is really great.

The comparative difference in cost per inch of weld for each electrode looks small—only $.000526 per in., but here is the difference in cost, and the amount which could be saved by using electrode A instead of B—on the following quantities of *purchased electrode,* based on the amount of

Table II—Electrode Costs Compared.

	A	B	Difference Saved
Inches of weld per pound of purchased electrode (Inches weld/lb. deposited weld metal x % deposited =)	91.02	77.27	
Cost/inch deposited	$ 0.003184	$ 0.003710	
Cost of 91.02" (weld 1 lb. of electrode "A")	$ 0.292	$ 0.338	$ 0.046
Cost of weld from 100 lbs. of purchased electrodes	$ 29.20	$ 33.80	$ 4.60
Cost of weld from 1,000 lbs. of purchased electrodes	$ 292.00	$ 338.00	$ 46.00
Cost of weld from 5,000 lbs. of purchased electrodes	$ 1,460.00	$ 1,690.00	$ 230.00
Cost of weld from 50,000 lbs. of purchased electrodes	$14,600.00	$16,900.00	$2,300.00
Cost of weld from 100,000 lbs. of purchased electrodes	$29,200.00	$33,800.00	$4,600.00

Table III—Deposition Cost of Metal

Labor $0.157 @ 66.7% efficiency =	.235 per lb.
Power — same as comparative test =	.060 per lb.
Electrode cost — same as comparative test =	.184 per lb.
Overhead at 200% labor =	.470 per lb.
Total cost in cents per lb.	.949 per lb.

OPERATOR _____ TEST NO. _____

OBSERVER _____ DATE _____

ELECTRODE DEPOSITION TEST DATA SHEET

(In this test the electrodes deposited must be burned down to a one inch stub. Such an electrode is considered completely burned. The total stubs of each sample of rod deposited must agree with the total of the stubs of the other sample within one fourth inch)

Electrode Number or Name	A	B
Machine used (make - size)	— Transformer	— Transformer
Serial number	1083 B	1083 B
Electrodes, Size and Length	1/4" x 14"	1/4" x 14"
Type	Downhand	Downhand
Number of rods deposited	8	8
Total weight of rods deposited (oz.)	28.8 oz.	30.0 oz.
Number of rods per pound	4.40	4.27
Plate (5/8x7x12") Weight after deposition, cleaned, in ounces.	267.0	264.0
Weight at beginning in oz.	246.7	244.4
Ounces deposited	20.3	19.1
Power open circuit voltage	55	55
Arc volts	34	35
Arc amperes	270	285
Arc time - total seconds	716	748
Labor ($ per hour)	$ 1.00	$ 1.00
Power ($ per kilowatt hour)	.025	.025
Electrode ($ per pound)	.13	.13
Lineal inches of standard test weld* - (Total of 4 burned electrodes)	82.75	73.25

* Standard test weld should be a weld which is standard in shop production. Each sample should be welded on a joint which has the same fitup, temperature, plate thickness and the beads should be the same size within regular production limits.

Fig. 11—Electrode test data sheet with the data from two different electrodes as it was taken during the test in the shop. Note the fact that the differences are all relatively small.

weld Electrode "A" will deposit is shown in Table II.

Comparative Costs

It must be remembered that the differences indicated between the above two electrodes are actually, measured differences which look small, and which can only be determined by tests. The tests are relatively simple and quite inexpensive. If a comparative saving of $46.00 per 1,000 lbs. of purchased electrodes can be realized by an afternoon's testing of electrodes it would be a profitable afternoon's work. Actually the above figures are not extreme by any means, and greater differences often are found in such tests.

The comparative cost of $0.401 per lb. of deposited metal from electrode "A" against $0.450 for electrode "B" is not a complete cost of the deposited weld metal. It includes all of the variable items of expense which depend on the character of the individual electrode. A close approximation of the complete cost of weld metal per pound for a given application can be derived from it. As an example of how to get such a cost the comparative cost per pound weld metal deposited by electrode A can be used. The only two items of cost not included in the comparative cost of $0.401 per lb. are (1) the cost of labor based on the relative amount of time the operator is actually burning the electrode to the total time he works on the job—setup, electrode change, etc. — (operation efficiency) and (2) overhead, which is usually charged as a percentage of the labor cost—both of these depend upon the shop or job—neither are entirely dependent on the electrode deposition process, so should not be included in comparative electrode tests. Referring to figure 12 the cost of $0.401 per lb. for Electrode "A" can be reworked to give a total cost per lb. of metal deposited by Electrode "A" as indicated in Table III.

Operation Efficiency

The most significant relationship between the electrode comparative cost of $0.401 per lb. and the total cost per pound of $0.95 per lb. is the fact that the labor and overhead (charged on the basis of labor) depends to an extent of 66.7% on the

actual burnoff efficiency of the electrode. Any increase in the efficiency of the electrode which reduces the labor item automatically reduces the calculated overhead and labor cost in the total cost per pound of weld metal. The reason comparative costs are not made to include overhead nor operation efficiency is that the real overhead costs vary with machine retirement costs, supervision costs, taxes and other such factory costs, not related directly to electrode characteristics. Operation efficiency costs depend on fixtures, helpers, etc., which are also items not based entirely on electrode characteristics. The figure of $0.95 per lb. of deposited metal does, however, give some indication of the investment which a welding establishment has accumulated in a welded joint containing a pound of weld metal.

Tests Advantages

There are many sources of profit from tests such as those outlined herein aside from the very important savings which can be realized by reducing costs on the job in the shop as it is performed at a given time by using a more efficient electrode.

One great advantage of knowing a comparative cost of one electrode to another on a given application is that it forms a basis for planning improvements in processing and design for greater economy. If, for example, it is found that a downhand type of electrode will give 125 ft. of completed weld on an application for the same cost as an all-position general purpose electrode will yield 100 ft. of completed weld, the unit can be examined for possibilities of making a fixture to position and to allow the use of the downhand electrode. Most important, it gives a basis for calculating relative costs. In the above case, a 25% improvement in efficiency of deposition of certain welds could be attained by positioning the work. Twenty-five percent of the cost of the amount of welding time involved on that particular application compared to the cost of the fixture immediately shows the investigator whether or not he can profit by building the fixture and using the downhand electrode. Often such studies result in very considerable savings in this manner.

Another common result of such studies involving the comparative costs of weld metal deposition is that the organization becomes more conscious of the real cost of deposited weld metal and the potential savings involved whenever a unit is redesigned to eliminate only a few inches of welding. It is undeniably true that the arc welding method of fabrication of a large portion of the machinery and other equipment used for modern living is the most economical from the material, functional, and practical standpoint; but it is equally true that even additional economies can be realized by the redesign of already economically arc welded units. Such redesign often occurs rather shortly after the real cost of weld metal, as deposited in an application, is really understood.

Conclusion

Still another result of accurate comparative tests of one electrode with another is that they more clearly define the characteristics of an ideal electrode for a given type of application. Much of the great progress made in the development of arc welding electrodes in the last twenty years has been the natural result of someone defining a real problem in welding and someone developing a good product to solve that problem. Accurate, objective tests always help to define problems, and what has been true in the field of electrode development in the past is still doubtless true. There are probably no really ideal electrodes for any modern welding application, and one of the most effective ways to get better ones developed is that of defining exactly what is needed by making comparative tests and finding not only what the best points of all are, but also what they all lack. The tests of today define the problems whose answers are the progress of tomorrow.

THE END

Calculated by_____ TEST NO._____

Checked by_____ DATE_____

ELECTRODE DEPOSITION TEST ANALYSIS SHEET

Electrode Number or Name	A	B
1. Percent of Electrodes Deposited = Ounces of sample / Ounces deposited	70.5	63.7
2. Pounds deposited per hour = 225 x ounces deposited / total arc time in seconds	6.38	5.75
3. Inches of standard weld per lb. deposited = No. of rods/lb. / 4 rods x in. deposited by 4 rods / % of rods deposited	129.1	121.3

COMPARATIVE COST PER POUND DEPOSITED

LABOR = $/hour / Pounds deposited/hour	$ 0.157	$ 0.174
POWER = Amps x volts x $/KWH / 1000 x operation efficiency x Lbs.Dep./hr. (use 60%)	0.060	0.072
ELECTRODE = $/lb. / % deposited	0.184	0.204
TOTAL COMPARATIVE COST/LB. DEPOSITED	0.401	0.450

COMPARATIVE COST PER INCH OF STANDARD WELD DEPOSITED

Cost/lb. deposited metal / inches of std.weld/lb. of deposited metal	$ 0.003184	$ 0.003710

Difference = .000526/inch
% Difference = 16.5%

Fig. 12—The data analysis sheet for the test shown in Fig. 11. These data analyses define the total differences in the efficiency of compared electrodes.

Resistance Welding and Refrigerator Manufacture

Spot, seam and projection welding as well as silver soldering play a part in the building of refrigerator evaporators. Accurate controls make it possible to weld many types of metal with the same equipment.

AN EXCELLENT example of how resistance spot-welding technique may be employed in manufacturing—even where the character of material to be welded may change materially is to be found in the set-up for producing refrigerator evaporators at Sunbeam Electric Manufacturing Co., Evansville, Ind.

Sunbeam, large producer of such units for a well-known organization selling through both mail-order and retail outlets, employs a total of 7 spot-welders and 2 seam welders (Fig. 1) to produce the entire range of evaporator units for all sizes of household refrigerators.

It makes no difference as far as the welding equipment is concerned whether these units are to be fabricated from stainless steel, enamel iron, or in between alloys. A variation in the type of material to be welded merely involves setting of a dial on the control on each machine and transformer heat-selector switch to produce the correct welding characteristics for the material selected. This feature is proving particularly important at the present time in view of difficulties experienced in obtaining stainless steel for non-defense production requirements.

The Evaporator

Refrigerator evaporators as produced at Sunbeam consist essentially of two sheet steel panels, one sheet is so stamped as to form a series of passages through which the refrigerant passes in evaporating. The other sheet is flat. These two panels are welded together in a manner that prevents the pressure of the gas inside of the passage from "springing" the panels apart at any point. The evaporators are required to withstand normal internal gas pressure of 250 psi, and a bursting pressure of 450 psi. One reason why this is possible is the large diameter of spots secured with the welding equipment used, preventing tearing of parent metal around the periphery of the welds.

Also included in the evaporator assembly is a baffle in the first passage between the two panel sides, as well as evaporator mounting and thermostat mounting brackets on the outside of the assembly. Just before completion of fabrication, the unit is formed into a U-shape to fit inside the refrigerating compartment.

In fabricating the evaporator assembly, the panels are first trimmed to size and one panel formed by

Fig. 1—A battery of resistance welders for making refrigerator evaporators at the Sunbeam Plant.

stamping on die-equipped presses. The formed evaporator half goes first to a standard pedestal type hydraulic spot-welder equipped with a double gun head. On this machine the baffle is spot-welded into one of the channels in the formed panel. This is done with two spot welds, the welds being made simultaneously and in series by the two welding guns. The baffle is placed in the movable head of the machine, where it is held in place on the fixture by two fingers. The panel is located over the lower electrodes. As the machine head moves down, the baffle is automatically located and welded in place. On completion of the weld, the fingers release automatically and the head returns, permitting removal of the assembled unit.

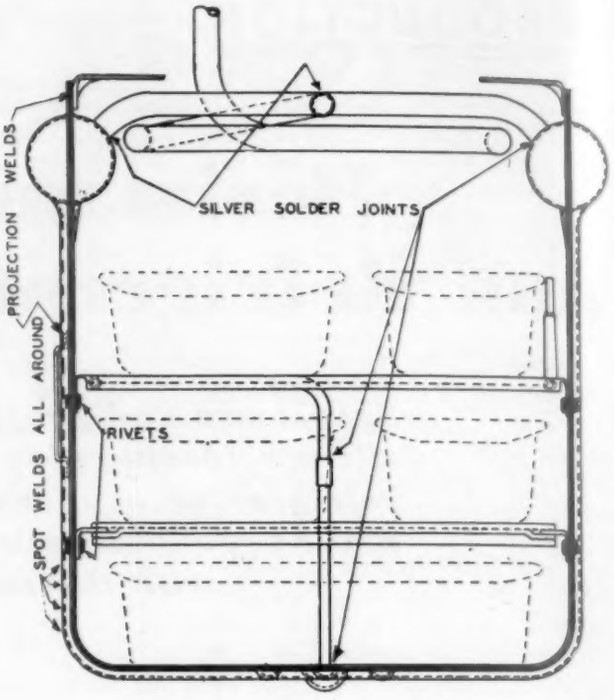

Fig. 2—A sketch of an evaporator — the product to be fabricated.

Multiple Spot Welds

This panel half now goes to another pedestal spot-welder equipped with a horizontally indexing (or ratcheting) table (Fig. 3). Both halves of the evaporator are placed in this fixture. The machine is started and automatically welds a series of 20 spots on one side of the center channel. The unit is then reversed in the fixture and a similar series of spots is welded down the other side of the channel. The machine is capable of a production of some 90 pieces per hour, for both series of operations.

The assembly now goes to one of three multiple-spot welding machines. These have six electrodes spaced so as to weld between each pair of channels on one side of center of the evaporator. On these machines (Fig. 4), rows of spot-welds are now made between each two channels, the spots being spaced approximately ½ inch apart by the operator who advances the unit this amount every time the upper electrodes release. The machine automatically repeats the welding operation as long as the operator keeps his foot on the starting switch.

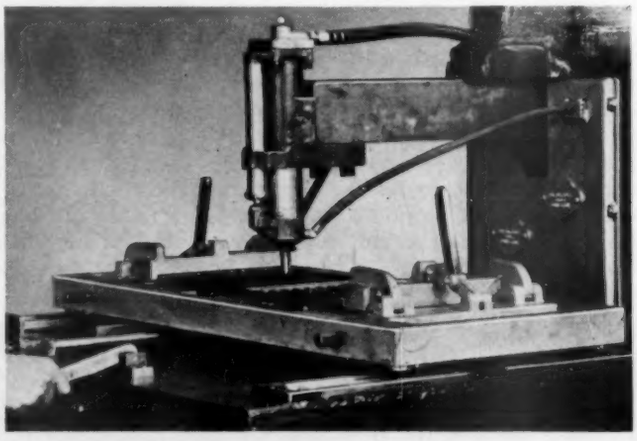

Fig. 3—Automatic indexing simplifies the welding of the center row of spots in the evaporator.

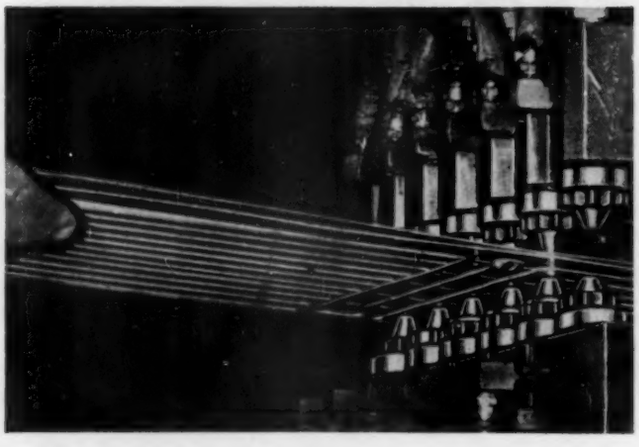

Fig. 4—Four or six spots may be made at one time depending on the evaporator size.

Seam Welding

On turning the evaporator around, the same operation is performed on the other half—either on the same machine or one of the other similar multi-spot welders. Design of the welders and evaporators is such that for smaller sizes of evaporators the end guns are merely cut out and the machine then welds four or five spots at a time instead of six. The machines are hydraulic in operation and controlled with electronic timers and contactors.

From the multi-spot welders, the evaporators go to two seam welders on which the outer edges of the assembly are welded together to seal them.

Projector Welding

After trimming the outer edge of the assembly on a press, the evaporator is bent into a U-shape on a forming press. It now goes to a projection welder on which the hanger brackets and thermostat control mounting clip are welded to the assembly (Fig. 5). This welder has three welding points. The two mounting brackets are welded on with the left and right electrode, while the center unit lo-

Fig. 5—The mounting brackets and thermostat clips are projection welded to the fabricated evaporator.

cates and projection welds the thermostat bracket to the evaporator.

Welding Controls

All of the welding machines are controlled through tube type contactors and synchronous electronic sequence timers which may be adjusted at the touch of a dial for welding times ranging from only ½ cycle of current to a weld time of approximately 60 cycles. It is the use of synchronous timing equipment which provides much of the adaptability of the equipment to welding either stainless or low-carbon steels. Consideration was given to possible changes in welding requirements when the equipment was first selected and designed. For stainless an extremely short weld time, accurately timed to the ½ cycle is usually required, while for low-carbon steel the weld time is materially longer. The use of synchronous equipment eliminates the variable effect of transient currents which are set up when contactors start the flow of welding current at any time except when the net value of the alternating current is zero.

Fig. 6—The finished evaporator is now ready for testing.

Silver Soldering Operations

The evaporator is now ready for the assembly of the various copper tubes and other fittings required to connect the evaporator with the refrigeration system. Referring to Fig. 2, it will be noted that the connections between the various copper tubes and the tubes and the evaporator are made secure by silver solder. The making of this type joint is quite simple. It merely involves the placing of a ring of silver solder about the tube, applying flux to the joint and heating it momentarily to allow the molten silver solder to flow into the cracks of the joint sealing them. After the silver soldering operation has been completed, the tubing and evaporator assembly is cleaned and pressure tested to withstand a bursting pressure of 450 psi.

The illustrations appearing in this article are reproduced through the courtesy of the Progressive Welder Co., Detroit, and the Sunbeam Electric Manufacturing Co., Evansville, Ind. THE END

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The Flow of Metal in Brazing Aluminum

By MIKE A. MILLER*

★ The brazing of many metals is an old art. Familiar examples are brazing with copper, bronze and silver alloys. Only recently, however, has the brazing of aluminum alloys been developed to a commercial stage. The three established procedures of torch, furnace and flux dip brazing require practically the same assembly and joining methods as are used for other metals, except that the temperatures are lower. Apart from the difficulties of finding appropriate fluxes capable of removing the tenacious oxide film, there was the problem of deter-

As a basis for defining flow, various fundamental relationships of capillarity were used; these include the flow of liquid into round tubes and between parallel and non-parallel plates, and the form taken by the brazing material in forming fillets. The experimental determination of the surface tension of the brazing alloy was carried out by allowing the molten alloy to rise in vertical round tubes and between non-parallel, abutting plates of aluminum. The data so obtained have been used to calculate the apparent surface and interfacial tensions of the molten brazing alloy in contact with solid aluminum alloys. These values, in turn, have been used to derive various practical relationships which have proven useful in the design of aluminum joints for brazing.

The apparent surface tension of a typical alloy for brazing aluminum, in the presence of an appropriate furnace brazing flux, has been found to be about 690 dynes per centimeter, and the interfacial tension of the same alloy against an appropriate dip brazing flux has been found to be about 250 dynes per centimeter. By substituting these values, as well as values for other constants, in the known surface tension equations, simple relationships between length of flow and clearance have been derived. Other equations have been solved to give the maximum height and width of fillets, the values being 0.3 in. for furnace brazing in air, and 0.5 in. for flux dip brazing.

Other factors related to the flow of brazing alloy have also been considered. These include such matters as time, temperature, the use of capillary traps, intersolubility of base and brazing alloy, the use of duplex brazing sheet whereby the brazing material is derived from the coating, porosity, flux-entrapment, and proper clearance. It has been shown experimentally, for example, that clearances of 0.025 in. are required in order to produce sound joints in laps of 0.25 in. or over; somewhat smaller clearances may be used in flux dip brazing. For line contacts and laps less than 0.25 in., permissible clearances may be substantially less. Explanations, based on the properties of aluminum, the brazing alloys and the fluxes, have been advanced to account for these relatively large clearances.

Aluminum brazing, although relatively new compared with non-aluminum brazing, appears to hold great promise and should enjoy a bright future. Efficient fluxes, satisfactory brazing materials, and duplex brazing sheet are available, and the process has already proven its worth in a number of commercial applications.

» «

Common sense extracts more solid comfort from life than a genius does.

» «

The most valuable result of education is the ability to make yourself do the things you ought to do when it ought to be done, whether you have to do it or not.—*Huxley.*

» «

We judge ourselves by what we feel capable of doing; others judge us by what we have done.—*Threads.*

*Research Metallurgist, Aluminum Research Labs. Presented at the 22nd annual A.W.S. Meeting, Philadelphia, Oct. 20-24, 1941.

Fig. 1—Finished core clamp for power transformer entirely fabricated by A-C welding. Note the smooth, uniform appearance of all welded joints.

Alternating Current Arc Welding

E. F. POTTER

Welding Engineer, Works Laboratory, General Electric Co., Pittsfield, Mass.

A-C welding is becoming increasingly prominent as defense production forges ahead. The reasons for this popularity are discussed in this article.

THE aim of every manufacturing concern is to obtain a maximum output in quantity and quality at a minimum unit cost. Likewise, fabricators of welded products must produce welds of maximum unit strength and quality at a minimum unit cost. On many applications this can best be done by the use of alternating current welding.

Most fabricators of arc welded products have accepted A-C welding as having a definite place in the welding industry. The reluctance of some fabricators to accept A-C welding might be due, perhaps, to too much theorizing. It has been sometime thought that the natural phenomena resulting from the unidirectional flow of direct current were essential for the best type of welding arc. The inception of A-C welding is not new; however, it remained for suitable coated electrodes to be developed for its successful application. Such electrodes have been made available only within the last ten years.

It is recognized that A-C and D-C types of electrical power have their advantages and disadvantages from the electrical and mechanical standpoints, and as a result each has its legitimate field of application. This is equally true and the limitations are much the same when A-C or D-C is considered for arc welding. There are applications where one type of current is more favorable and vice versa. An example of where A-C might not be as suitable would be production welding with low currents (below 75 amp.) on clean plate or some special alloy material for which a suitable A-C electrode might not be available.

Application

For practically all types of mild steel fabrication, suitable A-C electrodes are now available. When such work permits the use of welding currents of 200 amp. or more, requiring A-C electrodes of 3/16 in. diameter or larger, A-C welding is unquestionably more economical and better from the welding standpoint. Good results also may be obtained with lower currents and small diameter electrodes; however, with extremely low currents (75 amp. or less) some difficulty may be experienced in readily starting the arc. This condition is more noticeable when attempting to strike an arc with a new electrode on clean plate, especially if the coating is not flush with the end of the electrode.

It is accepted that coated electrodes are essential for the best results with A-C welding. With such electrodes the ionizing effect of the flux or ingredients in the coating aids in establishing and maintaining the arc. The gas formed by the coating must be definitely conducting so that the arc will be re-established each time the alternating current passes through zero.

Just as coated electrodes are considered essential for A-C welding it may also be said A-C is essential for the optimum results with certain types of coated electrode. This is particularly true of the mineral coated electrodes which may be used in a semi-conventional manner, that is, with the coating touching the work for single pass and the first pass of multiple pass fillet welds. This technique has two advantages when using the longer length electrodes. It definitely decreases the fatigue of the operator and it gives added assurance of the maximum penetration of the weld into the corner when making fillet welds.

The most important feature which has contributed to the advancement and increased use of A-C welding is the absence of any appreciable adverse magnetic action of the welding arc. Although magnetic action is used to advantage by electrical engineers in the design of such apparatus as

contactors, where it is used to prevent arcing—in arc welding the problem is to sustain the arc, not to extinguish it. Under certain welding conditions such as inside corner joints, at the extremities of straight welds, etc., it is often difficult to sustain a D-C arc. This being the case it is obvious that the arcing conditions are often not uniform with D-C. While this condition is less pronounced with heavily coated electrode and D-C, it is negligible with A-C. Electrode coatings are developed to perform certain definite functions under well established conditions so when conditions are not favorable defects are likely to occur.

Magnetic Arc Blow

The most frequent and common defects resulting from unfavorable conditions such as "magnetic blow" are slag inclusions and porosity. In fabricated structures having welds which must pass X-ray inspection, these defects are serious because they must be chipped out and rewelded. The experience of many manufacturers of high quality welded products is that the best remedy for these defects is alternating-current welding which helps the operator to avoid them.

The "magnetic blow" of the D-C arc increases with the larger diameter electrodes and correspondingly higher currents. Therefore, the greatest advantage of A-C welding is on applications where the larger diameters are or can be used. The uniform welding conditions obtained with A-C often permit the use of larger diameter electrodes than previously used, and in many cases higher currents may be used on the same diameter electrodes —all of which results in better quality and in higher welding speeds.

Fig. 2—When the work can be positioned for welding in the flat position, A-C welding permits the use of electrodes as large as ⅜-inch diameter without interference from "arc-blow." Thus, dependable, uniform quality is obtained at maximum welding speed.

Welds made in the flat and horizontal positions with A-C, including those made with large diameter electrodes, have physical properties equal to or better than welds made under the most favorable conditions with D-C. Today, slightly better physical properties may be obtained in vertical and overhead welds when made with D-C because slightly better D-C electrodes are available for these positions. However, in the final analysis, a weld is usually no better than the ease with which it can be made. On joints where "arc blow" is prevalent it is difficult to produce welds of good quality and appearance with D-C, yet no difficulty is experienced with A-C under the same conditions. It is the practice of some shops to supplement their A-C welders with enough D-C welders to take care of requirements for which no acceptable A-C electrode may be available.

Welding Speeds

When welding on heavy material vertical and overhead the largest diameter electrode normally recommended is 3/16 in. On the first pass 5/32 in. diameter is nearly always used and is often used on successive passes. Since an all position type electrode is used with either D-C or A-C little difference may be expected in welding speeds.

In making horizontal position fillet welds the largest electrode ordinarily used is ¼ in. If ¼ in. diameter electrode is used instead of 3/16 in. the welding speeds will be increased as much as 100% and the welding time reduced 25% to 40% (depending on the arc time). The average welder has the arc struck only 50% to 75% of the welding time.

Maximum welding speeds are obtainable on heavy material (5/16 in. and over) in the flat position where larger diameter electrodes may be used. The dameter of the electrode may be as large as the joint preparation will permit on butt welds, and on fillet welds the diameter of the electrode may be as large as the operator can handle. By using ⅜ in. diameter electrode instead of ¼ in. twice as much metal can be deposited in the same length of time. It is obvious, of course, that when using larger diameter electrodes the number of electrode changes per pound of deposited metal is greatly reduced.

When work can be positioned, the arc time, compared with vertical and overhead welding, can also be reduced because welding in the flat position is less tiresome.

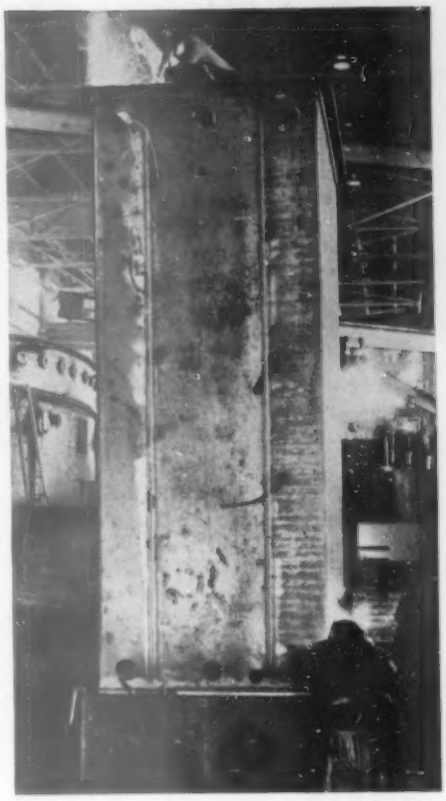


Fig. 3—A-C welding is ideal for horizontal fillets because it avoids magnetic disturbances and permits the successful use of electrodes as large as ¼-inch diameter with the result that welding speeds are twice as fast as though ⅛-inch diameter electrodes were used.

Training of Operators

On many welding jobs, especially those having single-pass horizontal fillets or joints which can be welded in the flat position where mineral coated electrodes may be used in a semi-conventional manner, the training time is much less. The trainees need not spend any time in learning how to weld in such a manner as to control the adverse magnetic action of the arc. The control of "arc blow" is something that most welders learn only after months, or even years, of experience. Unless they do learn this the quality of the weld is at times bound to suffer. This is not true when using alternating current. Proof of this lies in the fact that many older welders with years of experience can pass qualification tests with A-C but not with D-C in spite of the fact that they have been using D-C. Also, trainees often express a preference to be permitted to take their qualification test with an A-C welder.

Operation

Most of the latest and better type A-C arc welders provide a continuous range of uninterrupted current adjustments and may be raised or lowered while welding. Many are or can be equipped with remote control for

adjusting the welding current for manual or machine welding installations.

Cost of Operation

A transformer is inherently an efficient electrical apparatus. Consequently, when properly designed as an arc welder, it provides much higher efficiency than motor driven generators. The saving in power costs is in many cases sufficient to pay for the equipment in one or two years. It consumes very little power on no load.

Some of the later types of A-C arc welders are equipped with capacitors for high power-factor operation which reduces the full load primary current, and decreases the size of conductors, switches, fuses, etc., required for the power supply. Improvement of the plant power factor is also obtained particularly where induction motor driven units are used in the same shop.

The maintenance of transformer type equipment with its absence of rotating parts has always been low as there is little that can get out of order. About all that is required is that the dust be blown out occasionally and the current adjusting mechanism lubricated periodically.

There is little difference in the cost of installation between D-C and A-C, as the primary power supply requirements are often the same except that the A-C set is single phase while the motor driven set is usually three phase. In plants having three or more A-C sets, the single phase load can usually be divided so as not to be objectionable. The power and KVA demand of high power factor A-C sets are lower than D-C sets. A-C sets are particularly adaptable to small shops having only single phase power available.

Summary

The main advantages obtained from A-C welding may be summarized as follows:

I. Relative absence of "arc blow" which gives:
   - A, Added assurance of sound welds:
   - B, Lower costs by making it feasible to use larger diameter electrodes and higher currents;
   - C, Smoother and more uniform appearance of welds; and
   - D, Less time for training operators

II. Low cost operation by:
   - A, Higher electrical efficiency and
   - B, Less maintenance cost.

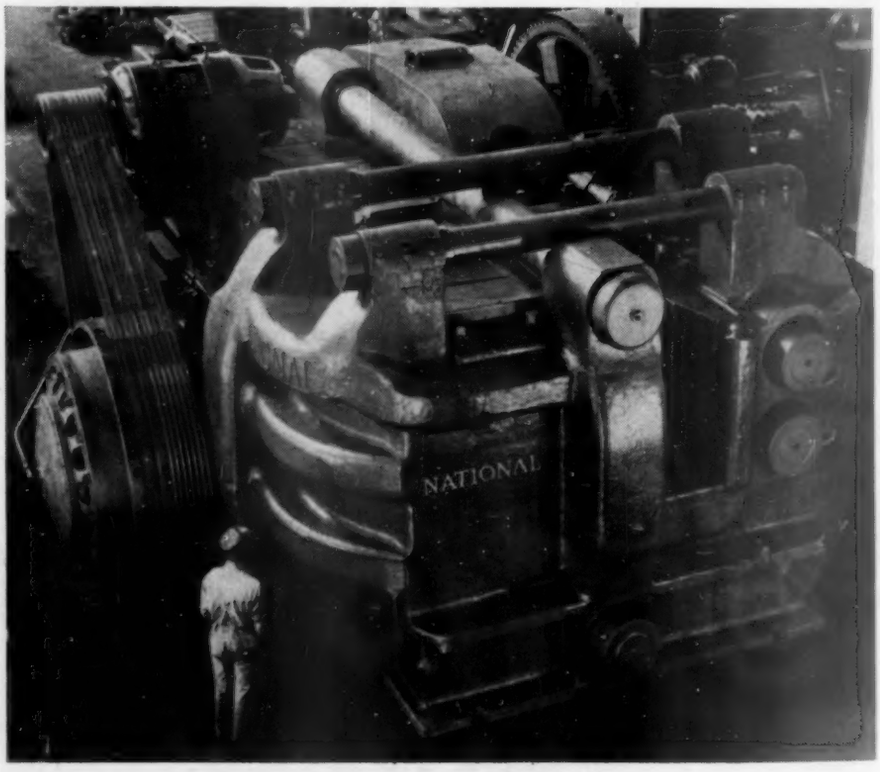
The World's Largest Forging Machine

A new machine for forging aircraft engine cylinder has 9 in. capacity. Weighs 500,000 lbs.

Tube-Turns, Inc., Louisville, Ky., recently received delivery on the world's largest forging machine. This machine will be used for the duration of the present defense emergency solely for the manufacture of airplane cylinders and other precise defense forgings. After the emergency is over, it is planned to put the machine into production of welded fittings but information as to what items will be produced is not available at this time.

This 500,000 lb. forging machine is classed as a 9 in. machine and is capable of forging bars up to 9 in. in diameter. Forgings of this type are made in a series of operations known as "steps," with the size, shape and amount of material used determining the steps required. The die blocks are of such height that 2, 3, 4 or 5 steps or die cavities can be installed in the die blocks. Each different cavity increases in size until the final step, where the finished forging is completed.

The movement of the dies and headers are engaged by an air valve which is operated by a foot pedal. When this pedal operates the air valve it engages the clutch which starts the movement of both the dies and header. The movable dies move across to the stationary ones which grip the stock and holds it firm while the header comes forward to upset the metal and fill the cavity. The header then returns to its original position and the movable dies move back so that the stock can be dropped to the second cavity for a similar operation. This cycle is repeated for the required number of steps until the forging is finished.



The mare is not a midget.

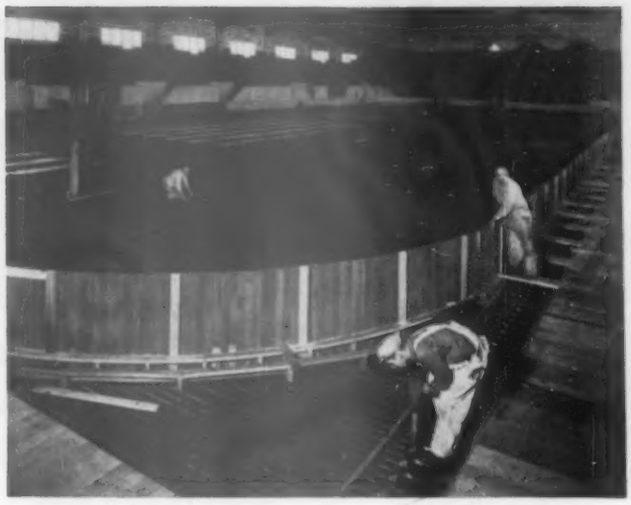


Fig. 1—All the brine pipes of the skating floor were joined by welding.

H. W. YOUNG

on

Welding and Ice Skating

Welding and weld fittings have simplified the problems encountered in the building of ice skating rinks. Construction details are given.

IF THE skaters visiting the Portland Ice Arena, Portland, Ore., were to follow the refrigeration pipes under the ice sheet, they would undoubtedly experience a full evening of skating. Looped back and forth under the thin sheet of ice which covers the 15,000 square ft. of the arena floor, is nearly 8 miles of 1¼ in. pipe. Few of those enjoying an evening of recreation realize there is so much piping required for their pleasure, similarly if you realize the other steps required to build a satisfactory ice arena.

The Portland Ice Arena is unusual in many respects but the outstanding feature is that which permits control of the ice freezing. In the case of many ice arenas, freezing is controlled only in large sections. Such an arrangement makes it impossible to control the freezing conditions in a specified area. Control is possible only in that one-third or one-fourth of the arena area involved. Localized control is possible as the result of the specially designed system of brine circulation in the Portland arena. When a soft spot develops on the surface, it can be given a localized freezing treatment. To obtain this condition, the brine pipes are connected in loops which run across the arena floor and back to a header, each loop having its individual control valves. Consequently, when a soft spot occurs, it is simply a matter of opening the valves of one or perhaps several of the loops under the affected area to permit a more rapid flow of brine. In this manner the soft spot may be refrozen without unnecessary "over-freezing" a large area.

The construction of an ice arena presents many interesting features and involves considerable work before the floor is ready to become a sheet of ice. First of all, there must be provided a sub-flooring of solid concrete. Over the surface of this concrete slab is placed a layer of cinders for insulation purposes and also to provide a level surface for the brine pipes. Waterproofing is next applied and then after the pipes have been placed in their final resting position on the center base, all of the space

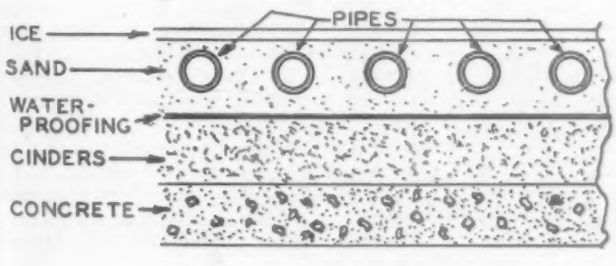


Fig. 2—A cross-section through the skating floor.

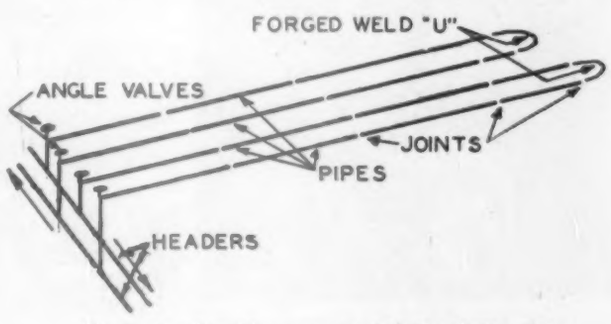


Fig. 3—A schematic arrangement of the skating rink refrigeration piping.

around the pipes is filled with washed sand until the pipes have been completely covered. It is on this sand surface that the ice is manufactured. In Fig. 2 there may be seen in cross section an elevation view showing the relative positions of the various materials used in the building of an ice rink.

Naturally, the most interesting phase of the work involved in the building of an ice rink is that in connection with the placing of the brine lines of the arena freezing system. The nearly 42,000 ft. of 1¼ in. pipe required for the 278 loops was obtained in standard lengths. All of this pipe, which was subsequently welded, contained 1,332 joints while the connections between the arena piping system and the headers and the engine room ammonia works required an additional 100 welds. Standard lengths were welded together so far as possible, but to make up a loop of a specified length it was frequently necessary to cut a piece of pipe to a specified length. In this case, it was cut either by power hack saw or by ordinary rolling wheel pipe cutters.

During the welding operations the refrigeration line pipes were placed upon 6x8 timbers which were laid edgewise on the waterproofing which covered the cinders. The lengths of the pipe were lined for butt welding and held in position by pipe hangers. Just prior to welding they were spaced so that the abutting ends were approximately ⅛ in. apart. Since those pieces of pipe which were cut with a pipe cutter had a slight bevel, the welder seemed to have a preference for those joints which were cut by the pipe cutter rather than the hack saw because the two bevels gave a slight "V" which made the welding somewhat easier.

Fig. 4—Welding in this position was not too difficult.

After the pipes were positioned about 4 in. center to center, which left less than 3 in. of clear space between them they were ready for welding. While the welding technique was somewhat varied, there seemed to be a general preference on the part of the weldor towards starting at the bottom on one side and laying a bead around the pipe to a point slightly above top center, then reversing sides, he would over loop the first bend slightly at the bottom and work up until the bead closed the pipe at the top.

As may be seen from the schematic layout, Fig. 3, each of the 278 loops were connected to brass angle valves and a header on one side, while the loop was completed by welding a forge welding "U" bend at the end of each pair of pipes forming a loop on the opposite side. The header, which was tapered, started with a 6 in. pipe subsequently reducing to 5 in., 4 in., and finally 3½ in. The nipples for the valve were graduated in height so as to bring all of them to the same level. These nipples were arc welded to the header at the factory; all of the field welds were made with the acetylene torch.

Operating in these close quarters, each weldor with his acetylene torch, was supposed to make 60 welds a day. This was usually accomplished despite the awkward position in which one had to work, consequently there was much moving around. Another of the difficult requirements which must be met by the weldors was the fact that each weld must be perfect as the finished job was to be tested at a pressure of 75 psi. before being turned over as "okay" for the 35 psi. service pressure. Under 75 psi. water test, any minute defect would show up readily. However, it may be said with credit to the weldors, that in over 1300 welds made on this job, there were less than a dozen faulty welds found.

Prior to freezing the initial ice rink surface the sand surrounding the brine pipes was thoroughly chilled. As soon as this operation was completed the sand floor was sprayed with water. Upon the formation of ice the surface was sprayed at various intervals until a sheet of ice of sufficient thickness to withstand the wear and tear imposed by hundreds of skaters was obtained. The arena was then ready to be opened to the public.

The installation was made for Edward F. Grell, owner of the Arena, by the Northwest Baker Ice Machine Co., Portland. Ernest Shandy was installation engineer of the company, had three weldors on the job.

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Photo Westinghouse E. & M. Co.

Forged fittings and welding makes piping streamlined.

Machine Flame Cutting in Shipbuilding

By E. R. McClung[1] and H. L. WAGENER[2]

★ The extensive application of the various gas cutting processes in the shipbuilding industry are correlaries to the development and extension of welding methods and welded designs. While the specific nature of a great proportion of the uses of flame cutting processes varies according to the type of vessel being built in different yards, and while all yards will naturally not make use of the same or even similar detailed procedure, the usages of these processes may be considered as a general proposition for the industry as a whole.

Nearly all of this country's shipyards make more or less general use of some of the more important applications of flame cutting such as straight line edge preparation with square or beveled edges, shape cutting, the preparation of special structural shapes, and many others. In recent years the shipyards themselves, and the manufacturers of apparatus, have developed many new specialty uses of the flame cutting processes which are making substantial contributions to the defense effort. Among these are equipment for scalloping edges of plates, straps, and flanges of shapes; for the improved cutting of armor hatches; for the preparation of "U" and "J" grooved joints; and for other uses too numerous to mention.

In view of the close ties between structural welding and flame cutting, it is imperative that the proper emphasis be placed upon the latter and that it be recognized for what it is; namely, a twin process to structural welding. For the proper coordination of the defense production of the shipbuilding industry, it is impossible for one process to function to the best advantage without the other. mining, and applying to practice, the flow characteristics of the molten brazing material on aluminum alloy surfaces.

[1]Asst. Supervisor of Welding.
[2]Asst. Foreman, Hull Department, New York Shipbuilding Corporation.
Presented at 22nd Annual A.W.S. Meeting, Philadelphia, Oct. 20-24.

More A. W. S. Annual Meeting Papers Reviewed

A continuation of a digest of papers presented at the 22nd Annual Meeting in Philadelphia. Previous condensations appeared in the November issue.

Adapting Structural Design and Construction Methods to Welding

By LA MOTTE GROVER*

★ To realize the greatest economy from the use of welding for steel structures, the construction materials, the designing and detailing, the general facilities and methods of fabrication and erection, and the organization of personnel, must all be adapted to welded construction.

Now that reliable procedures for welding have become quite well standardized, and shops have become organized to exercise proper engineering control over welding, results can be predicted with certainty, and costly confusion and delays have been eliminated.

Materials of Construction

Substantial improvements in electrodes, even since the adoption of the shielded arc, have done much to facilitate welding and to decrease its cost. The standardization in ASTM-AWS Specification A233-40T has eliminated confusion. By choosing the most appropriate type of electrode for each application, costs have been reduced.

High-strength electrodes are seldom needed in welding high-strength structural steels, and their use is likely to make the welding more difficult in many cases. Silicon steel, as now manufactured, is not recommended for welded structures because of its high carbon and lack of uniformity in chemical composition. A tentative ASTM specification for Low-Alloy Structural Steel, now accepted by Committee A-1, provides for specifying grades of high strength steel suitable for welding.

The trend is toward the adoption of specifications for nearly all steels that will assure their weldability with the most simple, economical welding procedures.

Design

Designers are continually using more original thought and ingenuity in designing all-welded structures; but it is still a common mistake, where some details of a structure are welded and others bolted or riveted, to specify a comparatively small amount of both welding and punching or riveting on the same piece, in such a way as to increase the cost of the shop work needlessly, because of extra handling of rather heavy pieces and other additional shop and field operations. However, welded details such as coverplates and stiffeners for rolled beams can be used to good advantage, even when field splices are riveted; although an all-welded design will improve the economy still further.

When continuous or rigid frame construction is used to take fullest advantage of the natural ability of welding to form economical and effective rigid joints and connections, then the greatest opportunities for cost savings are presented.

Although some details developed for riveting happen to be suitable also for welding, the amount of cost that can be saved by welding is nearly always proportionate to the degree of special adaptation of details to welding.

Shop and Erection Methods

Not only details of design, but also general methods of shop fabrication and erection must be adapted to welding to attain the best economy.

The punching of holes in main material for fitting up and erection bolts, often results in greater cost to move the material to and from the punch, than that of fitting up and erecting by means of tack welding and saddles, lugs, wedges, jacks and other devices.

Most shops position their work for down-hand welding (flat welds and horizontal fillets), but many of them still do not use high-melting-rate electrodes for such work, to attain greater speed and efficiency and the smoother welds of excellent physical properties that result from the use of such electrodes. There is a continually increasing trend to A-C welding in combination with larger diameter electrodes of this type for shop work. The most convenient sequence and direction of welding can be used without disturbance from magnetic flare, and distortion is largely eliminated through plastic deformation of the hot weld metal.

In most parts of the country there is enough favorable weather that a great deal of fabrication can be carried out in shop yards by welding and gas cutting, after use has been made of some of the shop facilities for the preparation of material. In this way the capacity of the shop can be increased at small cost to meet emergencies or to expand.

Welding is a most versatile method of steel fabrication. As design and construction practices continue to become better adapted to welding, even greater cost savings may be expected from its use.

*Structural Welding Engineer Air Reduction Sales Co.

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Flame Preheating and Stress-Relieving Arc-Welded High Pressure Pipe Lines

By P. T. ONDERDONK[1] and WERNER PETERSON[2]

★ The application of arc-welding to high temperature and pressure pipe for steam lines suitable for temperatures of 950 F. and 1500 psi or higher produced a demand for a suitable means of preheating the pipe and stress relieving the welding. The introduction of alloy steel and the heavy wall thicknesses needed for the large size pipe to carry the volumes of steam and water required by topping turbine installations of 50,000 to 60,000 KW capacity made it desirable to use such a means. The function of the preheat is to minimize shrinkage during the welding operation to preclude development of sufficiently high internal stresses to produce cracks either in the weld metal or parent metal adjacent the weld. The stress relieving operation is a continuation of this same function by relieving such internal stresses in the completed weld sufficiently to prevent failure when additional stresses are imposed by external loads in service.

A number of methods of accomplishing this problem have been developed and used for this purpose. Some are applicable to shop practice only and others may be used for either shop or field work. Those which appear to have received the most favorable consideration can be divided into essentially two classes, i.e., electric and flame methods. Those employing electricity are referred to as the resistance and the induction methods. The flame methods usually used are based on utilizing some of the more common fluid fuels such as fuel oil, kerosene, illuminating gas, and oxy-acetylene in a temporary or portable

[1]Inspection Engineer.
[2]Junior Engineer, Consolidated Edison Co. of New York, Inc.

Photo General Electric Co.

High-Tensile Steel Plus Arc Welding Gives Bigger Tank Truck Pay Loads.

brick type enclosure incorporating a suitable torch arrangement or in a multi-jet, ring-type burner.

As a result of changing field erection requirements, a demand arose for supplementing or replacing the electric methods previously employed with a flame method, preferably of an improved nature, adapted primarily to field use. A study of available furnaces, burners, and fuels led to the development of a very satisfactory method employing propane. A portable furnace to accommodate heating torches suitable for the use of this fuel was designed to permit readily mounting it for use on a pipe to pipe or pipe to fitting weld. The development of this equipment, the economic and physical factors influencing the selection of propane gas as fuel, and the experience obtained in actual field application of this method are described in some detail in this paper.

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The Effects of Plate Temperatures and Variable Wind Velocities on Properties of Carbon Steel Metal Arc Welds

By J. L. MILLER[1] and E. L. KOEHLER[2]

★ Open hearth fire box quality plate 1¼ in. in thickness was metal arc welded employing initial plate temperatures of 70 F. and 32 F. while exposed to wind having velocities ranging from zero to 20 mph. In all cases, after one bead of weld metal had been deposited, the test plate was permitted to cool to the original plate temperature before subsequent beads were deposited. Radiographic examination of the completed welds indicated that porosity and the amount of slag entrapped in the weld metal increased directly with the wind velocity obtaining during welding. As the wind velocity during welding increased, the oxidizable elements, manganese and silicon, in the weld metal decreased to less than 50% of values secured at no wind velocity. At the same time, the nitrogen content of the weld metal increased by over 100% as the wind velocity during welding increased from zero to 20 mph. All-weld metal tension test specimens showed a progressive decrease in percent elongation with increase in wind velocity, but yield strengths and tensile strengths were but slightly affected. Transverse plate and weld metal bend test results showed a progressive decrease in elongation in the outer fibres of the specimen as the wind velocity increased. The impact resistance of the weld metal, as measured using Charpy notched impact specimens, decreased with increase in wind velocity during welding.

It was concluded that good quality welding could not be produced when the arc was exposed to a moving air stream having a velocity much in excess of 5 mph. Shielding should be employed if possible and the use of heavily coated electrodes is advocated. It is believed that the detrimental effect of low initial plate temperature and increasing air velocity at the arc are increasingly damaging as the weldability of the steel being welded decreases.

[1]Metallurgist, The Firestone Tire & Rubber Co.
[2]Illinois Institute of Technology.

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The Electrical Characteristics of Resistance Welders and the Proximity Effect of Magnetic Work Materials

By J. H. COOPER*

★ An explanation is given of the Welding Capacity versus the Thermal Capacity of a resistance welder in an effort to clear up a very common point of confusion. To do this, it is necessary to cover how welders are given electrical ratings, the information put on nameplates and why this has no connection with the welding capacity or ability of the apparatus. By necessity, the fundamental circuit formulas and calculations must be included, as well as the relationship between thermal capacity rating and the power demand necessary to provide the required welding ability.

Having established the above background, the welding performance of a resistance welder can then be related to and predicted by the welder impendance and welder load impedances.

Actual values of welder impedances compiled from hundreds of tests are given and cover all standard welders in light, medium and heavy sizes, ranging from 10 to 75-KVA and 6 to 48 in. throat depth.

The proper method of adding the impedances due to both the work material in series with the secondary circuit between the tips as well as due to the proximity effect of magnetic work materials is given.

Methods of determining the above variables are followed by mathematical examples.

*Welding Engineer, Taylor-Winfield Corp.

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Demand Improvement for Resistance Welders

By H. R. CRAGO*

★ With the continued increase in the use of resistance welding requiring machines of higher rating and with improved welding technique requiring closer voltage regulation of the power supply, the problem of reducing the KVA demand of the resistance welder from the power system is receiving considerable attention. Energy storage equipment of the electro-magnetic and the capacitor discharge types have gone a long way in solving the problem for some classes of welding but there remains a wide field of application to the conventional single phase welding machine, both new and existing, for which demand reduction is desired and for which demand reduction equipment is available.

Two generally accepted methods for improving the demand characteristics of resistance welders are available: The motor generator method in which the single phase load is distributed over the three phases of the power system by the use of a single phase generator driven by a three phase motor and the power factor correction method in which the low power factor load of the welding machine is raised to a higher value by means of capacitors. While the motor generator method has probably been more widely used in the past, present day manufacturing technique has so reduced the cost of capacitors that this latter method offers a means for affecting the same degree of improvement at about 35% of the cost.

In addition to the cost advantage of the capacitor method, advantages are also offered from the standpoint of stand-by losses, upkeep and space requirements. The advantages offered by the motor generator method lie principally in the three phase distribution of power but this is a questionable advantage considering the fact that the current per phase is practically the same as in case of the same load corrected to unity power factor. The reason for this is because of the losses in the generator and motor and because the motor load

*General Electric Co.

is at reduced power factor. The motor generator method offers some advantages in the case where a number of welders can be supplied from a single set because, due to the intermittent nature of the load, the set need be no larger to handle several welders than for a single welder provided the individual machines are interlocked to prevent more than one machine being connected to the set at once.

Where loads have been increased beyond the capacity of the plant secondary bus system causing interference between welding machines or where the demand from the power system is causing light flicker complaints or increased demand charges corrective measures at the load should be given consideration and cost comparisons made before any major power supply reinforcement is considered. In most comparisons advantages gained per dollar of cost favors corrective measures at the load.

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Divergent Nozzle Tips for Economical Oxygen Cutting

By J. J. CROWE,[1] G. M. DEMING[2] and J. K. HAMILTON[2]

★ An investigation has been carried out to determine whether more economical oxygen cutting would result from the use of cutting tips fashioned with a divergent exit portion. A systematic analysis of the effect of the various design variables and detail test cuts have led to the development of a tentative series of divergent cutting tips for the range of material thickness up to about 8". Using these tips, it is possible to reduce the cutting oxygen consumption 25 to 45 percent, as compared with standard forms of tips when operating at speeds previously used. It is also possible to operate at speeds 20 to 25 percent greater than those obtained with standard tips when using the same oxygen discharge rate employed with the standard tips.

These gains result from the narrow high velocity emerging oxygen stream and consequent narrow kerf which is 30 to 50 percent less than when standard tips are employed. The quality of cuts made with these tips is comparable with that obtained using the most precise of the standard tips.

Various new methods were employed for evaluating the stream characteristics with the result that the number of test cuts was materially reduced.

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Aluminum Alloy Resistance Spotwelding

By P. H. MERRIMAN*

★ The aluminum alloy spotwelding process provides the engineer with a new and valuable method of attaching metal parts together. Not only are spotwelds exceptionally strong and inexpensive to make, but their extremely smooth surface appearance in this age of high speed airplanes makes possible decreased aerodynamic drag without the extra expense of flush type rivets or screws.

The ease with which a spotweld can be made and the realization of its smooth appearance is made possible only through the medium of highly refined mechanical and electrical equipment operated under extremely close production control.

Electric resistance spotwelding, as applied to steel, has been in successful use for several decades. Due to the critical metallurgical properties of the aluminum alloys, however, particularly their narrow plastic range and high electrical conductivity, the methods and equipment applicable to steel were hopelessly inadequate when applied to the lighter alloys.

It was realized early in the investigation of the process that, not only would exceptionally high currents be required, but that the magnitude and duration of the weld current must be held to within limits which were impossible to maintain on a production basis.

The development of the mercury vapor contactor, called the ignitron tube, is largely responsible for the rapid development of the process in this country. This device makes it possible to control extremely heavy currents with ease and accuracy. Inspired by this development, welding equipment manufacturers developed high capacity welding transformers capable of delivering the currents necessary for aluminum alloys and built around these transformers precision-made welding machines capable of applying the welding pressure accurately and consistently.

From this point on, the aircraft manufacturers have taken up the problem and further developed the equipment to suit their individual requirements; and the present success with which aluminum alloy spotwelding is being used is a joint tribute to both equipment and airplane manufacturers.

The magnitudes of welding current required for aluminum alloys are beyond the layman's comprehension. For a representative thickness of aluminum alloy used in aircraft construction, 25,000 amp. are required; and this current flows for a period of only 1/10 of a second. Only the very smallest variation from these figures is allowable in order to produce welds of acceptable physical and metallurgical quality. For example, a difference of 500 amp. or of 1/100 of a second may seriously affect the quality of the weld.

In order to put aluminum alloy spotwelding on a production basis, it is necessary that all variables encountered in the process be automatically maintained once they are set so that it is merely necessary for the operator to set a few dials according to predetermined settings and to operate a button to produce welds.

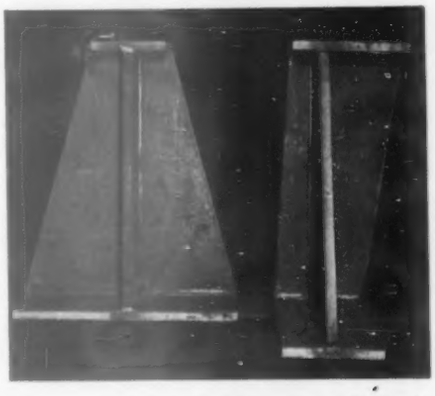
This requirement is not important in steel welding where the operator can judge the quality of the weld he is making merely by observation of the color of the metal under the electrode tips or by the volume of sparks which are expelled during welding. An aluminum spotweld is made without any visible indication whatsoever, and the operator must rely on the validity of the settings he is using.

The success of the process depends to a large extent on the caliber of the shop personnel doing the actual work as well as continuous engineering supervision. We are, at the present time, conducting classes among our spotwelding operators to acquaint them with the basic technical details of the process and methods of improving their work so that the value of spotwelding as an engineering method and a production tool can be improved.

The most important factor, however, in realizing the maximum possibilities and production economies of the process lies with the man who designs parts for spotwelding. In his hands rests the answer as to whether or not a given part is economical to spotweld. In a large number of cases, lack of consideration of this point results in the design of a spotwelded assembly which is actually more economical to rivet. The Design Engineering Group in the Engineering Department and the Spotwelding Group in Tool Design are constantly endeavoring, by mutual cooperation, to give guidance in the matter of economical spotwelding design.

These groups should be freely consulted regarding the most economical way to apply spotwelding to designs. Discussion between draftsmen and members of these groups over a drawing board has frequently resulted in the saving of thousands of dollars in the Shop by simplifying a design for production.

Due to the almost limitless possibilities of this method of manufacturing, continuous development work is being pursued along the lines which will increase production speed, reduce costs, and extend its value by application into newer fields. The thought of a completely spotwelded airplane serves as an impetus for continuous development work on the problems which stand in the way. The most outstanding of these problems are: development of better machines and methods for higher production, continued investigations into fatigue and corrosion resistance, development of superior spotwelded joints,



Structural welding is becoming exceedingly popular for defense buildings.

[1]Asst. to Vice Pres. and Operating Manager.
[2]Apparatus Research and Development Department, Air Reduction Sales Co.
*The Glenn L. Martin Company

development of portable welding machines, development of less expensive equipment.

It is hoped that, by this brief outline of the process, that you men, who are responsible for the design of the airplanes, may have a more intimate knowledge of this vital production process so that you may apply it in your work in a manner which will enable our company to make more airplanes per day at less cost.

» «

Condenser Discharge Welding of Aluminum Alloys

By J. W. DAWSON[1] and B. L. WISE[2]

★ The condenser discharge form of stored energy welding has had a marked influence upon the application of resistance welding to aircraft design and fabrication. The authors attempt to review and analyze this influence rather than attempt to set forth the detailed technical aspects of the process itself.

An historical review of stored energy welding shows several interesting investigations of this subject over the past thirty years. A major impetus to the use of the process, however, awaited its introduction in aircraft welding, where it offered a solution to the power supply problem. An important second advantage of particularly the electrostatic form of stored energy equipment is the production of higher quality and more consistent aluminum alloy spot welds at higher production rates.

Greater accuracy in this new electrical supply equipment, delivering a single direct current pulse, led naturally to mechanical refinements of the welding machine to match this new electrical supply. Greater electrode pressures were adopted, requiring greater mechanical rigidity. At the same time, considerable advancement was made in the accuracy of static and dynamic pressure delivery. Still further, practically all modern energy storage welding machines employ dual or multiple pressure cycles.

Early spot welding equipment was made universal in form to handle various gauges and shapes. Present trends are to more specialized machines and to higher production rate machines, such as the roll-spot and quite possibly jig and fixture machines with appropriate energy storage supply equipments.

It is submitted that cost considerations are often incorrectly made. Cost considerations should be made on the basis of welded fabrication costs, rather than upon any arbitrary cost of installed welding equipment. On this basis, the most expensive welding equipment may be, and generally is, the least expensive in terms of its use.

The electrical and mechanical functions of the welding equipments have now probably been brought to a higher degree of perfection than the other factors in the aluminum alloy spot welding process, such as surface cleaning and welding tip maintenance. Both of these factors are still subject to variances between individual machine operators. Fortunately, surface cleaning problems have now been rationalized by recent research findings. Welding tip maintenance has been much alleviated by the use of electrostatic storage welding equipments, and measures are also being taken to maintain welding tips to a standardized configuration.

The subject of weld quality and weld inspection is at present a most controversial issue in aluminum alloy spot welding. The authors respectfully question whether the quality of present aircraft welding is not overly suspected because of occasional cracks in the weld structure. Perhaps metallurgical perfection is being over-emphasized in the absence of sufficiently thorough practical investigations to determine structural adequacy.

[1]Raytheon Mfg. Co.
[2]Federal Machine & Welder Co.

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Tests of Miscellaneous Welded Building Connections

By BRUCE JOHNSTON[1] and GORDON R. DEITS[2]

★ The primary purpose of this investigation was to check the adequacy of certain types of welded building connections now being used in actual practice. The laboratory specimens were designed similar to details on actual design sheets. Twenty-one beam-to-column connections were tested in all and there were five different types of connections, classified into groups, as follows:

Group I. The beam web is welded directly to the column or girder by fillet welds, or as an alternate, side plates are used to bridge the clearance beyond the end of the beam web.

Group II. (a) A seat angle carries the vertical reaction and the beam web is supported laterally by a side plate or clip angle.

(b) A seat angle carries the vertical reaction and a top plate is fillet-welded to the top beam flange and butt-welded to the column flange or web.

Group III. A tee is welded to the column or girder, with provision for slot and fillet welds between the outstanding leg of the tee and the beam web.

Group IV. In these connections a clip angle is shop-welded to the beam web with filler welds. Erection bolt holes are provided in the outstanding legs of the angle. After bolting up, the beam web is butt-welded to the column or girder with the weld laid over the shop fillet weld.

Group V. These consist of several different methods used for spandrel beam connections applied eccentrically to one column flange.

The 1938 edition of the American Welding Society Handbook, together with design data sheets prepared by the American Bridge Company and Bethlehem Steel Company, was consulted in designing the specimens. The specimens, however, do not necessarily represent design practice approved by any one of these organizations.

The investigation was not expected to furnish complete information about any one type. It was intended to test designs which might prove either good or poor, therefore, the inclusion of a connection type in this program does not necessarily indicate it to be good design.

A satisfactory connection must perform two functions:

(1) Carry the vertical reaction load with ample safety.

(2) Permit the rotation which would be required between the beam and column in an actual frame and at the same time be strong enough to resist the end restraining moment which is developed.

With regard to (1), all of the connections showed an adequate shear factor of safety with respect to the design reaction. Two connections are excepted because they could not be tested in the supplementary shear test.

Many of the connections yielded before developing a satisfactory rotation, but prior to initial weld or plate fracture all of the connections except two showed a rotation factor of 1.70 or more as compared with the design requirement for balanced reaction and moment design. Whether or not this rotation reserve is sufficiently safe in all cases may be a debatable question. Rotation failure of some types of connection would result in damage to the reaction carrying welds if not collapse of the connection. Rotation failure of seat angle types would not damage the reaction carrying welds which are a part of the independent seat angle.

Many connections designed only for vertical reaction are inherently semi-rigid, thereby developing end moments which may not have been considered in the design. Such connections may not be strong enough to carry the end moments imposed by the normal tendency for the ends of the beam to rotate when the beam is loaded, in which case the design is faulty. In the design of welded connections it can not be too strongly emphasized that end restraint and flexibility, as well as shear or reaction, must be given due consideration. The mere assumption of simple-beam end conditions is not adequate.

This investigation is one of a series which has been sponsored at Lehigh University by the American Welding Society. The program forms a part of the activity of Committee G on Structural Steel, of the Industrial Division of the Welding Research Committee of the Engineering Foundation. A special subcommittee was organized to work on the Lehigh test program. The tests throw light on some incorrect design procedures and may therefore prove of help in developing better designs. More laboratory tests of some of the connection types will undoubtedly be made in the future and these tests may help indicate the direction such programs should take.

[1]Associate Director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pennsylvania.
[2]Formerly American Welding Society Research Fellow, Lehigh University, Bethlehem, Pennsylvania.

Automotive Welding

By S. M. SPICE,[1] VAUGHN FEGLEY[2] and L. M. SKIDMORE[3]

★ This age we live in is known as the age of metals; it is fast becoming the age of welded metals. Structures ranging from thousands of tons to fractions of ounces are being welded today and then proving their worth in an age that is hard to please. Greater than ever before is the strength per unit of weight now obtained.

The economic advantages of welding are to be seen everywhere. In general, welding is much faster than the old mechanical methods of attachment. Sections may be reduced and structures may be fabricated in smaller units which may be handled and shipped more economically. Raw materials are conserved by reduction of weight and elimination of much waste. Worn parts are built up again, often to give better service than originally. Replacements are cut down and down-time for repair is reduced in an important degree. All this means savings in dollars and cents that are incalculable as a whole and gives the buying public far more for their money than ever before.

Because of all this we travel faster, accomplish more in a shorter time, and in general enjoy a better and more exciting life. This brings us to the automotive industry where the growth of welding has been at least as phenomenal as in the other metal industries. Again the economic advantages are recognized and the possibilities probably exceed the applications. Designers are now thinking in terms of welding and no longer have to be pushed into a welded design. As a matter of fact, the shoe is on the other foot and designers are pushing the welding engineers around. This in itself is a healthy sign of the future.

Automotive parts, except for a few notable exceptions, are much more economically resistance welded. This is true because of the requirements of high production, and of the comparatively small size of the parts. Arc and gas welding are just as important to the automotive industry as resistance welding but find their best application, not in production, but in machine structure fabrication, machine repair, maintenance, hard surfacing, material salvage, and other applications.

Of the various forms of welding, it is an unquestionable fact that resistance welding has made the greatest advancement in automotive production work in recent years. Resistance welder manufacturers are denied the full glory of this statement because the stride has been set by the manufacturers of the associated equipment, i.e., alloy electrode materials and electrical controls.

We are making welds today that a very few years ago were economically and practically impossible, almost entirely due to these same controls and alloys.

Welder manufacturers are taking advantage of these better controls and alloys and must continue to do so. There is a big field for improvement in the welding machines themselves. The machines must be more accurate, friction and inertia weight must be reduced, tooling and gauging must be improved, and many another refinement included which the automotive manufacturer will applaud.

Some of the latest types of welding machines and power distribution systems in use at Buick and AC Spark Plug Divisions were described. These descriptions in themselves show the trend today and for the future. Borderline cases of resistance vs. arc welding were described and the reasons for choosing one or the other given.

Automotive axle housings and frames are mostly arc welded while automotive bodies combine resistance, arc and gas welding with resistance welding predominating. Various uses of arc and gas welding for the repair of grey iron castings in production, also in machine repair and maintenance, particularly for foundry, forge and sheet metal shops, are described. In these applications, the cost savings in material, in scrap and in lost time, are a major item.

Conclusion

The welding industries of today are having the growing pains that attend the growth of all big business. The users are sharing much of the pain with them; this is particularly true of resistance welding.

How to determine good welds from bad is a problem. At this stage, the best answer is the use of better equipment plus a more understanding maintenance.

We have tried to show present advances, and from these indicate future trends plus the needs of the automotive industry.

The use of welding will grow in spite of all of us, but it will grow much more painlessly when the problems of both user and manufacturer are better understood.

[1]Buick Motor Div.
[2]AC Spark Plug Co.
[3]General Motors Institute of Technology.

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The Tee Bend Test to Compare the Welding Quality of Steels

By GEORGE A. ELLINGER,[1] MORGAN L. WILLIAMS,[1] and A. G. BISSELL[2]

★ The marked increase in the use of welded construction in place of riveted construction has involved more than a simple substitution of one method for the other. The design for riveted construction is not necessarily equally as suitable for welding; in fact, materially different designs are often necessary for identical structures fabricated by riveting and by welding. Not all metals were equally satisfactory for welding and different welding techniques were necessarily employed for making the same types of joints in different metals. In selecting the metal best adapted for the strength requirements of the design and utility of a structure to be assembled by welding, the welding quality of the metal, within the limitations imposed by the practicability of the welding method is of prime importance.

The welding of medium steel offers little difficulty provided proper attention is given to design and welding technique. However, the use of high tensile low alloy steels to reduce size and weight of members often created difficulties due to differences in welding qualities of the steels.

In an investigation authorized by the Bureau of Ships and conducted at the National Bureau of Standards, the welding qualities of eighteen commercial steels were studied by means of bending of fillet welded tee specimens of the steels in special jigs. Six of these steels were also welded and tested at subnormal temperatures as low as —20F. The welds in the specimens were not machined.

The angle of bend at maximum load and the type of fracture in the bend test were the governing factors in comparing the welding qualities of the steels. The data were evaluated by means of a special method of statistical analysis which is described in detail.

Steels which contained large number of nonmetallic inclusions generally had lower welding qualities than those which contained few inclusions. The high temperature grain size and grain coarsening temperatures apparently had little effect on the welding qualities of these steels.

Steels normalized at 1650 F. before welding had higher welding qualities due probably to more homogeneous structures of the metals.

Hardness surveys indicated that none of the steels hardened appreciably upon welding and that there was no correlation between hardness properties and welding qualities as determined by this investigation. Likewise no good correlation was found between the ordinary tensile properties (yield point, tensile strength, and elongation) and welding qualities of these steels.

Steels welded at low temperatures usually had lower angles of bending and a higher percentage of failures in the parent metal than those welded at room temperature. However, the temperature at which the tests were made apparently had more effect on the results obtained than the temperatures of the plates when welding was started.

Bend tests made on specimens of a steel with cast fillets and with welded fillets proved that the test was not a function of the geometrical shape of the specimen but was an indication of the welding quality of the steel. Likewise the width of specimen is not critical and within certain limits does not appreciably affect the results of the bend tests.

[1]U. S. Bureau of Standards.
[2]Bureau of Ships, Navy Department.

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If a man didn't make an occasional mistake his fool friends wouldn't have the pleasure of criticizing him.

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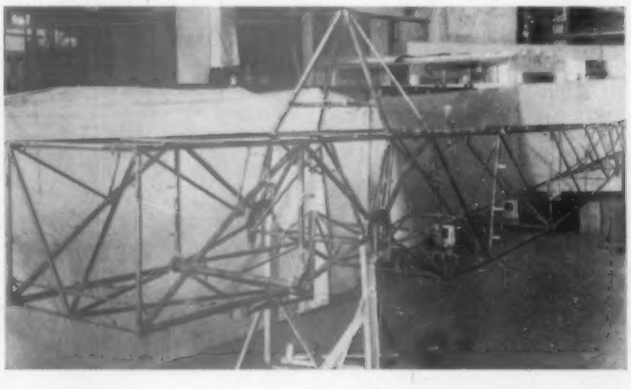

Welding and steel tubing forms the backbone of the airplane—the fuselage.

The Technical Slant

The man who doesn't read good books has no advantage over one who can't read them.

Aviation

FLIGHT—AVIATION ENGINES. *By Ray F. Kuns. Published by American Technical Society, Chicago, 1941. Cloth, 6x9 in., 363 pages. Price $3.25.*

Aviation Engines is the third of the Flight Series* and is an up-to-date revision of material formerly published by the Junior Air Service of America.

This book starts with a discussion on elementary engine principles and then goes into details regarding aircraft engine fuels, mixtures, carburetor design, use and repair of carburetors, fuel engine tanks, induction systems and superchargers. Upon having mastered the functions of fuel in the aircraft engine, the reader is introduced to ignition, spark plugs, radio shielding and storage batteries, followed by a discussion of starters, starting motors, generators and accessories.

While the book discusses in great detail the component parts of aircraft engines, there is also a thorough discussion of the various makes of light plane engines which are so popular. The radial aircraft engine is also touched upon briefly with excellent material on valve, ignition, timing and lubrication.

So that the book will be more valuable to the student, it is closed with a series of quiz questions and answers to see that complete information is obtained from the volume by the reader.

» «

Labor Laws

THE FEDERAL WAGE AND HOUR LAW (QUESTIONS AND ANSWERS). *By Arthur W. Nevins. Published by The National Foremen's Institute, Inc., Deep River, Conn., 1941. Cloth, 5½ x 8 in., 64 pages. Price $1.50.*

This handbook of the question and answer type is intended for executives and supervisors in all types of business, upon whom falls the burden of saving their company's money by seeing that unwitting violations of the Law are avoided.

The book, through approximately 100 questions and answers, gives up-to-the minute rulings pertaining to the Wage and Hour Law. Many of the answers are those which have been given in connection with court rulings in actual examples cited. Because of this feature, it should prove extremely valuable as a reference for executives, supervisors and department heads concerned with the functioning of Federal Labor Laws.

» «

Machine Design

TOOL DESIGN. *By C. B. Cole. Published by American Technical Society, Chicago, 1941. Cloth, 5½x8½ in., 481 pages. Price $4.50.*

With a shortage of tool designers to meet the needs of our National Defense Program, Tool Design is indeed a timely book.

In this book information is given regarding the selection of proper materials followed by data on the design of tools used in practically all industries. One of the outstanding features is the profuse use of illustrations and drawings. These drawings have been taken from actual tool designs in the production field and have been selected to cover a wide field in many industries. The typical designs that are presented illustrate principles that will find many and varied applications in other tool designs.

In addition to the drawings, the discussion of the text is quite complete. At the end of each chapter there have been added quiz questions which will make this work not only extremely valuable as a reference book, but also suitable for home study or classroom work.

Tool Design will fill the need of beginners in tool design and will also be of practical value in helping experienced men solve their design problems.

» «

Safety

EYE HAZARDS IN INDUSTRY. *By Louis Resnick. Published by Columbia University Press, New York, 1941. Cloth, 6x9 in., 341 pages. Price $3.50.*

Eye Hazards in Industry is an up-to-date revision of Eye Hazards in Industrial Occupations which was published by the author in 1924. As the name implies, the book is designed to discuss eye hazards present in industry and occupations of all sorts, as well as to show means of eliminating or at least guarding, the worker against those hazards which cannot be eliminated. As such, it can be readily classed as an extremely valuable book for those engaged in sight conservation in particular or safety work in general.

The author originally prepared the text material as a report for the National Society for the Prevention of Blindness. The material is highly authoritative, having been obtained by personal interview with society officials, supervisors and injured workers, as well as by collaboration with numerous persons engaged in safety work.

In reality, the book is divided into two parts, the first section dealing with the problem, i.e., eye hazards, eye accidents, eye diseases, defective vision and first aid, while the second part discusses the solution, e.g., mechanical guards, proper accessory, proper lighting, education and administrative supervision.

Aside from serving as a handbook for those engaged in safety work, it is believed that Eye Hazards in Industry is also suitable as a textbook for engineering schools, vocational supervisors and others who are preparing new workers for industry.

Welding

WELDING PROCEDURE. *Published by Air Reduction Sales Co., New York, 1941, Paper, spiral bound, 8½x11 in., 64 pages. Price 60 cents.*

The proper welding process for a particular metal under various circumstances is clearly outlined in this 55 page book. In addition to recommending the process, there is suggested the best filler metals to be used for each process, and describes specialized welding techniques not commonly known. In an appendix, data is given for the calculation of electrode and gas welding rod consumption for different types of welds; also comparative welding record sheets for tabulating data that will determine the best welding method for a particular job.

The book will awaken welders to the fact that where a choice exists between two or more processes, the operator is prone to use the process in which he is most adept, without stopping to consider the ultimate cost. By use of the cost data sheets in the book and by gaining a keener appreciation of the fields for which gas or arc welding is particularly fitted, the operator will be able to produce better welds at less cost.

» «

MANUAL OF INSTRUCTIONS IN WELDING AND CUTTING. *By Boniface E. Rossi. Published by McGraw-Hill Book Co., Inc., New York, 1941. Fabricoid, spiral bound, 8x10 in., 99 pages. Price $1.00.*

The author has written a book divided into two parts which discusses arc and oxy-acetylene welding and cutting. The discussion is presented in the form of shop assignments with the first 22 assignments devoted to metallic arc welding with bare electrodes. Most of the material is based upon the author's experience as Director of Welding at the Delehanty Institute.

Following the instructions on the bare electrode, there are 23 assignments on welding with the coated electrode while using the metallic arc, followed by an assignment on carbon arc welding and carbon arc cutting.

The second part of the book is devoted to oxy-acetylene welding and cutting. In this section, information is given regarding the setting up of the apparatus, the making of simpler welds and then followed by a complete discussion of welding in various positions and the welding of various material. There are 19 shop assignments on oxy-acetylene welding and cutting, one of which is devoted to the oxy-acetylene cutting of plates and pipes.

The Manual of Instruction in Welding and Cutting is quite complete and should be found very useful during this time when the proper instruction of student weldors is so important.

*See The Welding Engineer June 1941, page 34.

There's the STAINLESS STEEL WELDING ELECTRODE YOU WANT"

• It's listed on page 6 of this booklet on Stainless Steel Welding and Electrodes that has been prepared by PAGE.

•

You probably know as well as we do that you must look for and insist on getting two distinctly different *kinds* of quality in your Stainless Steel Electrodes.

It is imperative for good Stainless Steel Welding that the deposit *in the weld* be equal to the Stainless Steel you are welding.

It is just as important that the electrode be of the shield-arc type, to protect the metal in the weld; equally usable in horizontal, vertical and overhead positions; permit high speed welding with minimum spatter and slag loss and smooth beads.

To get all those qualities for you, PAGE worked in the field and laboratory with the world's largest producers of Stainless Steel —until they said every PAGE Stainless Electrode was *right*.

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Be sure to ask your local PAGE Distributor for a copy of this valuable, well illustrated booklet on the welding of Stainless Steels. It covers the entire subject.

PAGE WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION • MONESSEN, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc.

Brief Sketches of Welding Jobs

Prefabricated tie-ins save time and money in making field tank connections.

Unitized Tie-ins for Tank Batteries

By Elton Sterrett

By welding the standardized manifold connections used to connect oil wells to the separator at the lease tank batteries, so as to permit most of the work to be done in the yard instead of in the field, one welder has simplified the field work of tying-in. Likewise, such a set-up makes all such assemblies interchangeable.

A single union is incorporated in each set-up, with screw threads only on the connections for the gate valves—to permit replacement of a valve in the field without cutting lines or requiring a weldor's services—the units being made up in pairs and accurately fitted as to overall dimensions and spacing.

With such a unitized manifold, only tie-in connections are required in the field. All lining up and spacing already has been performed in the yard. To cut in the manifold, it is necessary only to cut the field lines to abut the connecting sections of the manifold, and to weld it in place. The company estimates that such unitizing saves enough time on the maintenance gang over previous field make-up to enable five tie-ins to be made at the cost of three earlier type connections.

» «

Welded Stock Trailer

Job shops and garages equipped with an arc welder can assemble the salable livestock trailer in one day's time for less than thirty dollars. Such a trailer can be easily assembled by two weldors in eight hours' time. Most parts can be obtained from the junk pile.

First, a cutting torch was used to shape the flooring made from ¼ in. bridge steel to shape. Flooring was welded to side beds made from the same size steel. The braces for the bed were constructed from old Ford frames welded firmly to the bed and to each other. Side stakes are ⅞ in rods in one inch pipe stake holders. Strips that form the sides of the trailer are ⅛x3 in. iron tank hoops. All strips are welded to the side stakes. A 1¼ in pipe was welded around the trailer top for extra bracing and to insure smooth corners. Tongue was made from ⅜ in. by 7 in steel braced with two and one half inch angle iron.

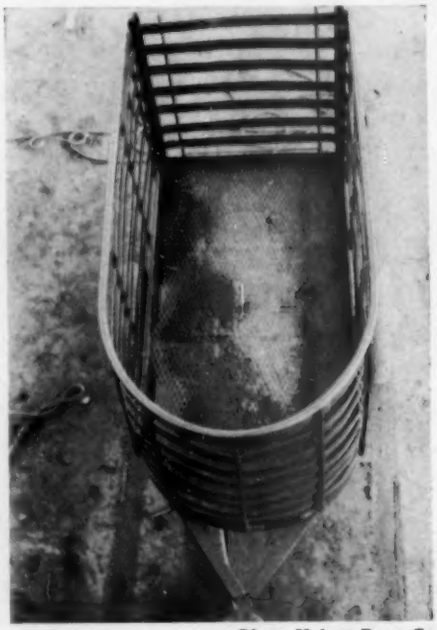


Photo Hobart Bros. Co.

Welding makes the construction of such a trailer an easy task.

Tail gate can either be lifted out or hinged down to form a livestock loading walk. Total cost including labor is $27.62. A number of these trailers have been built and there is a ready market for them. Selling price—$45.00.

» «

A Portable Shop

Many and varied are the home-made welding rigs which we see in our travels around the country.

Shown in the accompanying illustration is one of which Axel Hanson, proprietor of the Utility Welding Shop, Ludell, Kansas, is very proud.

Photo Lincoln Electric Co.

Anywhere at anytime with this traveling welder.

The welder is completely covered with tin, powered with a Buick six motor and mounted on a shortened Buick chassis. The sides are removable and a hinged lid, over the back, houses a compartment large enough to carry all necessary electrodes, portable grinder and other essential tools. Handles are welded to the lid for opening the compartment and a bracket, (at rear end of truck), furnishes facilities for winding up the welding cable.

» «

All-Welded Dipper

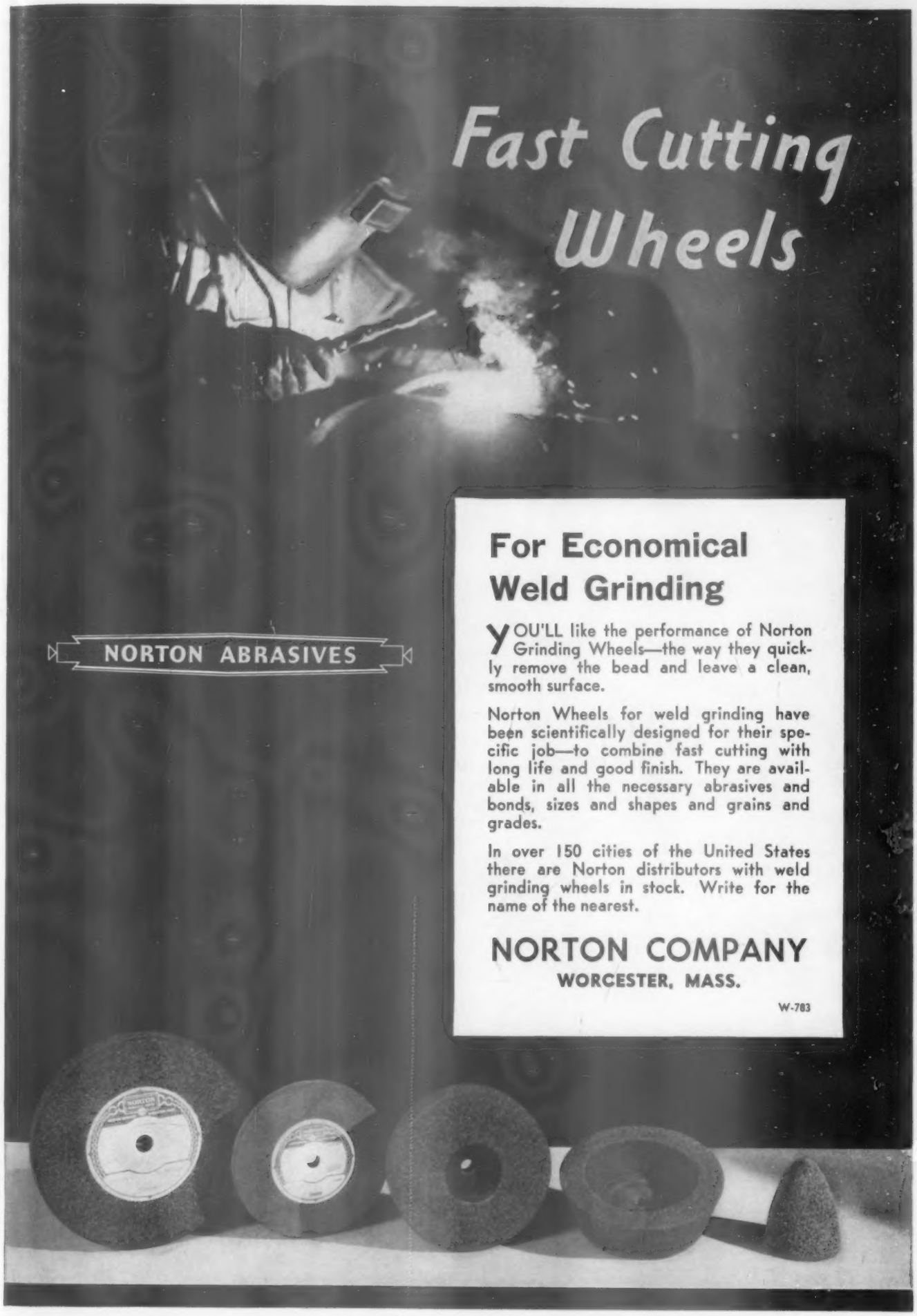
Shovel dippers must be built to withstand severe abuse, for this reason the Harnischfeger Corp., Milwaukee, is using all-welded construction on its new 1½ cu. yd. shovel dipper.

Through the use of welding, the heavy dipper shell can be reinforced and made quite sturdy in a very simple manner. One of the important features worked out in the design is the absence of corner welds—a feature achieved by forming the dipper back of the parent metal instead of the inserted plate type back. This feature tends to reduce wear and when coupled with the increased stability gained by welded construction results in a superior dipper.

A dipper all-welded for greater strength.

» «

We judge ourselves by what we feel capable of doing; others judge us by what we have done.—*Threads.*


Fast Cutting Wheels
NORTON ABRASIVES
For Economical Weld Grinding
YOU'LL like the performance of Norton Grinding Wheels—the way they quickly remove the bead and leave a clean, smooth surface.
Norton Wheels for weld grinding have been scientifically designed for their specific job—to combine fast cutting with long life and good finish. They are available in all the necessary abrasives and bonds, sizes and shapes and grains and grades.
In over 150 cities of the United States there are Norton distributors with weld grinding wheels in stock. Write for the name of the nearest.
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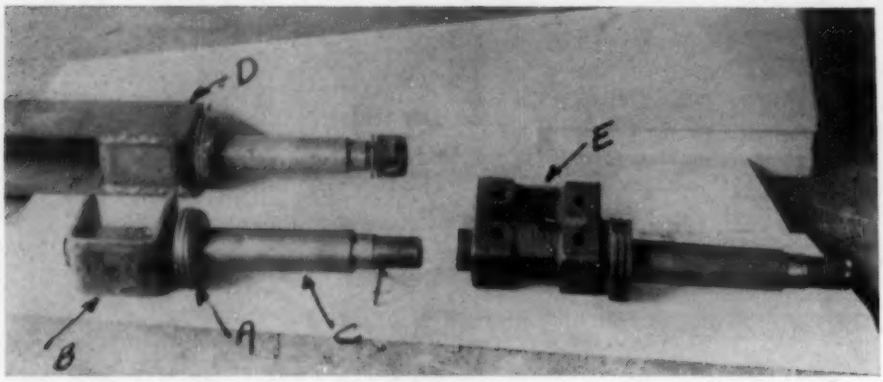


Hobart Bros. Co. Photo

Welded axle spindles are lighter, stronger, and cheaper.

Welded Axle Spindle

The Peru Wheel Company, Peru, Illinois, have been successfully replacing the casted rear axle spindle for all farm trailers with a spindle of arc welded construction. Advantages claimed are: Replacements eliminated; prompt deliveries; lower cost; more rigid construction; omission of bolting. The old method of assembly "E", as shown in the picture above, has been replaced by the welded assembly consisting of spindle "C", collar "A", and clevis "B".

Method of assembly is as follows: Spindle "C" was cut threaded and drilled; collar "A" was punched and formed—then welded to spindle. After machining grooves in collar and facing to length, clevis "B" was welded to the spindle. The entire assembly was then jigged and welded to the "U" shaped axle section shown at "D". Cost of welded assembly is $1.21 (including labor). Cost of cast iron assembly was $2.10.

» «

A Jib Crane

By C. C. Lynde

A heavy wooden box within a welded pipe frame is used on oil-well drilling rigs for carrying miscellaneous heavy parts, the unit being winched onto a truck and skidded to a location near the next job. The heavy valves, flanges and other equipment frequently weigh too much for one man to handle, and the loading and unloading requires two or more men at a time when man-power is needed at many points.

The weldor for one drilling contractor equipped the usual "junk box" with a jib crane which enables one man to do all work around the box, a post some four ft. in height being welded at the center of one end of the box frame. Hanging within the open end of this post is a short jib crane, welded up from heavy pipe, a 90 degree elbow fitting within the post and serving as top support and swivel.

The thrust of the load is taken by a yoke, formed from half of a pipe coupling, which spans the post near its base and maintains jib alignment. Hoisting equipment consists of an all-welded winch which, with a four-part fall and hook, enables parts weighing several hundred pounds to be lifted by one man, swung over the box side, and lowered without assistance. A pawl on the frame brace provides locking of the winch to hold the load at any desired elevation.

An easily obtained yet strong jig crane.

» «

Ore Unloader Repaired

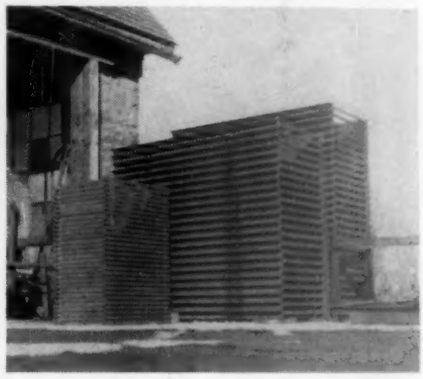
With steel mills operating at peak production, it is highly important to keep iron ore dock equipment in first class running condition. The indispensable man at the docks these days is the welder whose job is to repair any breakdowns as quickly as possible without dismantling the equipment.

When the intermediate hoist gear broke on a giant ore unloader, it would have taken at least 12 hours just to remove the gear for repairs. By the use of electric welding, it was possible to weld the gear while in position, and the unloader went back into action after a shutdown of only 4 hours.

» «

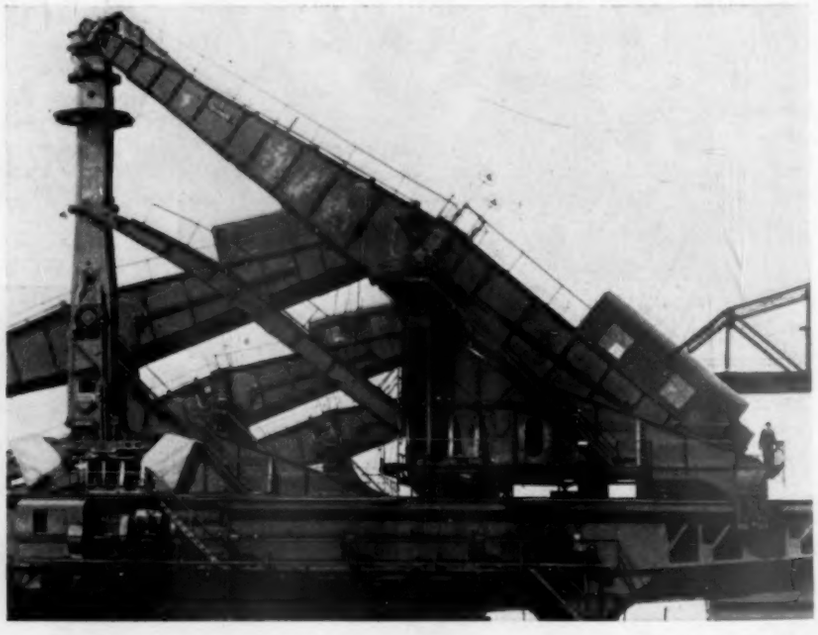
Tile Dryer Cars

Simple changeover to arc welded construction by the Central Brick & Tile Company of Tilbury, Ontario, has resulted in a 50% cost reduction for the company in the construction of tile dryer cars. A weldor can assemble one of these 35 in. x 76 in. cars every seventeen minutes. These efficient handling cars are stronger and more flexible as a result of the changeover in construction from the rivet and bolt method. Cost of cars by arc welded construction is $17.21. Previous cost of cars by the rivet method was $34.10.



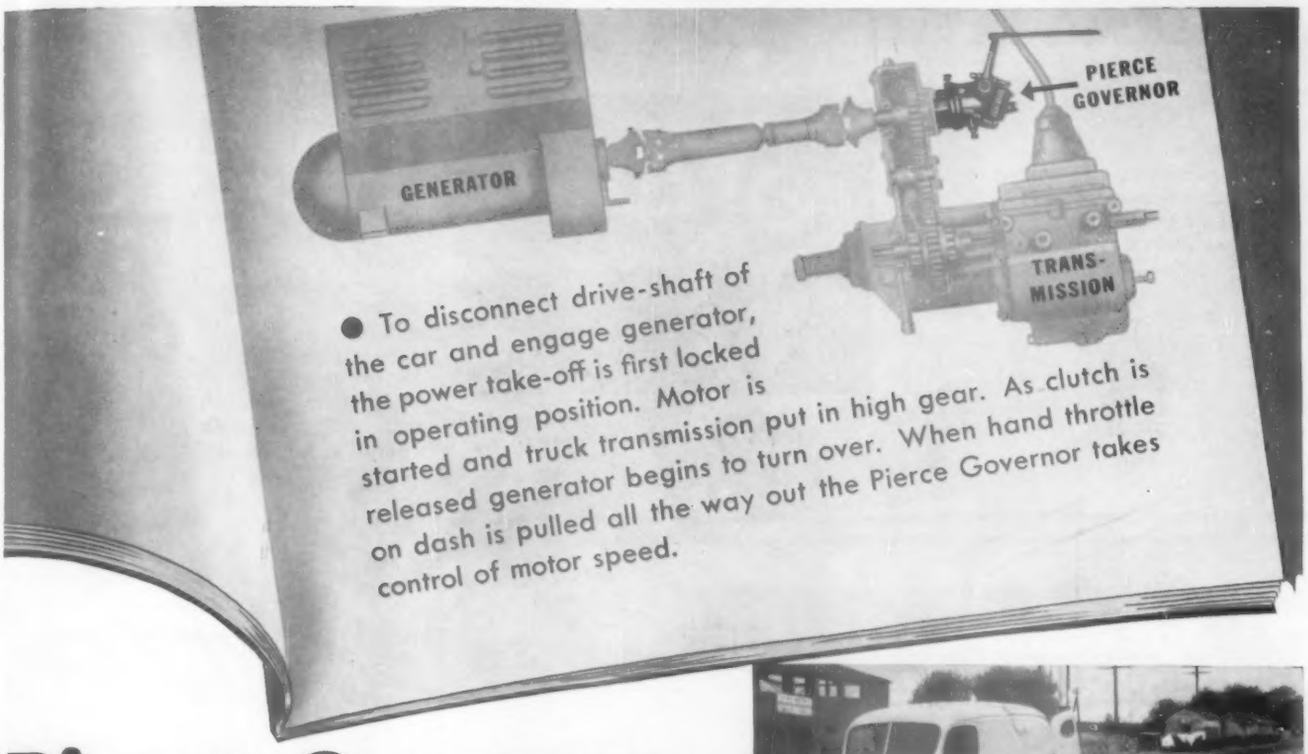
Hobart Bros. Co. Photo

Tile dryer cars at half price by welding.



Westinghouse E. & M. Co. Photo

Welding saves hours in the maintenance of this type of equipment.



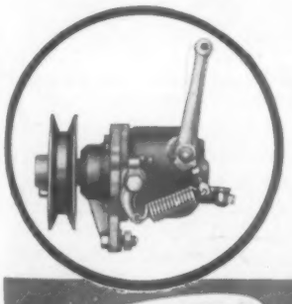
● To disconnect drive-shaft of the car and engage generator, the power take-off is first locked in operating position. Motor is started and truck transmission put in high gear. As clutch is released generator begins to turn over. When hand throttle on dash is pulled all the way out the Pierce Governor takes control of motor speed.

Pierce Governor

PROVIDES CLOSE SPEED CONTROL ON NEW TOURNACAR WELDER

● Many advantages in field welding service are offered in the new Pierce-equipped Tournacar Welder. A distinctly original development is the design of the power take-off from the transmission for operating the welding unit which is conveniently placed inside the panel-truck service-car.

The power take-off provides a substantial gear-driven mounting for the Pierce Governor, which is adjusted for a governed limit between load and no-load of 1900 to 1975 rpm, giving split-second recovery of current after striking arc.



THE PIERCE GOVERNOR COMPANY
1607 OHIO AVE. • ANDERSON, INDIANA

Pierce Governors are standard equipment on most engine-driven welders. If you are building a welder write us for data on governing. To be sure of the weld you must be sure of the governor!

Tournacar welding a railroad switch.

Service where service is needed. Repairing a bumper.

On the job without delay. Welding teeth on shovel bucket.

Pierce Governors

STANDARD SINCE 1913

Production Costs Cut

By N. H. Bolz

A 50 per cent sales increase and savings of as much as 40 per cent in overall production costs and 40 per cent in time are being realized by the Paterson-Leitch Co., Cleveland, in the fabrication of coal hoppers and press brake housings.

Prior to the adoption of welding, riveting was used in the fabrication of coal hoppers. The use of arc welding has also substantially speeded production, as the omission of rivet-heating and hole-punching has cut many minutes from the time previously needed to build a coal hopper, and the product is lighter and better appearing.

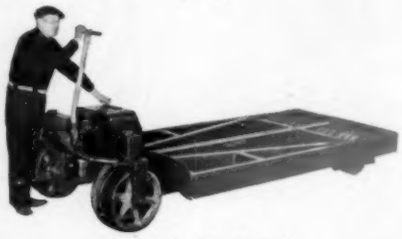
General Electric Photo

Welding a press brake housing.

In addition, the company reports that parts used in the fabrication of press brake housings were formerly cast, and are now completely arc welded eliminating the necessity for drafting, making patterns, and casting. More sturdy construction and reduced weight are also obtained, as standard steel plate, cut to correct size, can be used with this method of fabrication.

The user states that in his opinion dependability, versatility, and low cost of operation are the outstanding attributes of arc welding.

» «

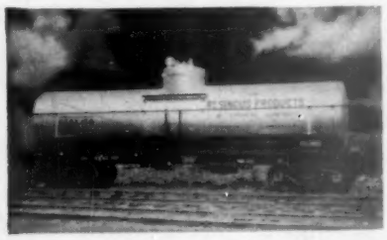


Welded for hard service.

Super Duty Truck

Welded construction makes it practical. For this reason the Lewis-Shepard Sales Corp., Watertown, Mass., are building extra large hydraulic hand lift trucks with capacities of up to 35,000 lbs. of welded construction. Since welding makes it possible to build a truck frame which can be rigidly braced in every direction to prevent deflection and weaving, the long equipment life is assured. On the other hand, the truck is light in weight and can readily be moved about the plant. Such trucks are now exceedingly popular since they are capable of handling large machine tools.

» «

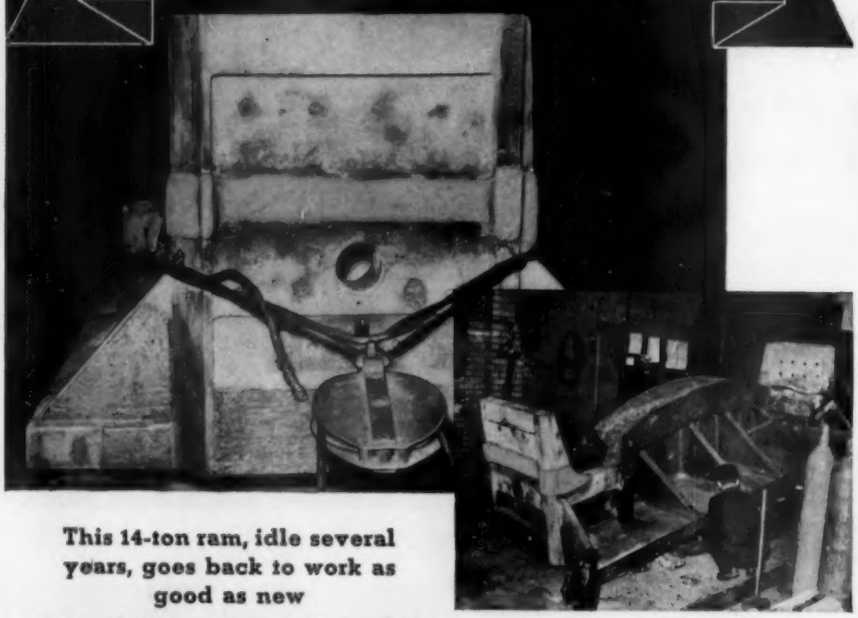


Another tank car whose contents are protected against contamination.

Stainless Clad Tank Car

15,000 lbs. of stainless clad steel was used in the construction of an all-welded stainless steel clad tank car built by the General American Transportation Corp. at their Sharon, Pa., plant. This car follows the innovation of welded stainless clad construction for use in the building of tanks to successfully resist the chemical attack which would take place if ordinary steel tanks were used for the storage or transportation of corrosive or easily contaminated products.

Speeding defense through Tobin Bronze Welding!



This 14-ton ram, idle several years, goes back to work as good as new

Rams of this size take months to manufacture and deliver. So, when this one was found coincidentally with a call from a defense job for such a piece of equipment, everyone felt quite happy . . . for awhile. Inspection revealed a badly patched fracture which probably occurred many years ago.

Undismayed when it examined the ram, the Super Arc Welding Company of Detroit set out to put the equipment into first-class operating condition...by Tobin Bronze Welding. After three days of adjusting the parts, they started preheating and welding. Three days later, with the help of 1750 pounds of Tobin Bronze, this ram went to work for national defense.

• • •

Tobin Bronze and other Anaconda Copper-Alloy Welding Rods are always "on call" for national defense work. 41139

ANACONDA Anaconda Welding Rods

THE AMERICAN BRASS COMPANY—General Offices: Waterbury, Conn.

Subsidiary of Anaconda Copper Mining Co. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

New Product Developments

High Pressure as well as High Capacity.

High Capacity Regulator

★ **Victor Equipment Co.**, San Francisco now manufacture new regulator unit claimed capable of delivering with maximum pressure accuracy over 100,000 cu. ft. of oxygen hourly.

The spring-loaded diaphragm regulator at the right of the illustration reduces primary cylinder pressure from 2000 psi to a desirable maximum operating pressure of 250 psi. The center "T" connection manifolds together the primary and secondary stage Master Regulator, as well as the smaller Pilot Regulator. This Pilot Regulator controls the diaphragm loading pressure of the large diameter second stage reduction regulator, which is of the Victor patented "Gas-O-Dome" type. The Pilot Regulator, is said to prevent accidental overloading of the diaphragm and enables the operator to adjust final operating and delivery pressure accurately and safely. The entire unit is equipped with self-seating and bursting disc type relief valves at all pressure stages.

All regulator seat mechanisms are easily accessible and damaged seats may be exchanged for new ones without major disassembly.

Both inlet and outlet accommodate standard ¾-in. pipe connections usually employed in cylinder manifolds.

» «

Safety Spectacles

★ The **Tulca Division,** Univis Lens Co., Dayton, Ohio, has added a new, rimless-type, safety spectacle to its eye protection line. The **"Supervisor" spectacle** is fitted with the company's special material (not glass) Tulca Safety Lenses. They come with or without side shields.

According to the manufacturer these safety spectacles are as comfortable and as pleasing in appearance as regular eye-glasses because of the extremely light weight of the Tulca Lenses. An important safety feature claimed for the Tulca Lenses is the fact that they do not pit.

A neat looking Safety Spectacle.

» «

Cover glasses and electrodes are always handy.

Weldor's Accessories

★ The **Safety Clothing & Equipment Co.**, 7016 Euclid Ave., Cleveland, announce two new weldors' accessories designed to promote speed and safety. One of these items is the **Cover Glass Case,** a chrome leather case with a snap fastener which slips on the belt which is made for carrying spare cover glasses. The second item is a chrome leather, two-compartment **Electrode Carrier** which is furnished with a web belt.

» «

A-C Welders

★ **Glenn-Roberts Co.** announce a new unit in the G-R line of A-C welders known as the **45-H Dual.** This welder, which is designed for heavy duty operation in either single or dual circuit manual welding or with automatic welding head, has a current range of 50 to 570 amps. on a single welding line or 50 to 300 amps. on each of two lines. The manufacturer claims extreme flexibility for this unit which is said to be capable of an output of over 500 amps. which will handle most heavy work in either manual or automatic welding, while its low of 50 amps. is readily available for light work with little sacrifice of efficiency. It is available with rubber tired wheels mounting for easy portability.

Model 45 with a range of 100 to 625 amps., represents an improvement over the previous model in this range. It is claimed that design changes have eliminated a high proportion of hysterises and eddy current losses, giving the new unit an overall efficiency of 90.6% of maximum rate output.

Two operators at once may use this welder.

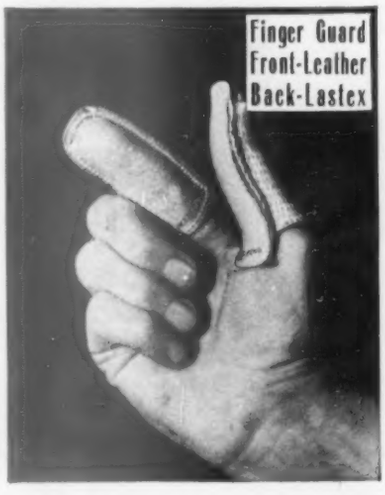
Both new G-R units may be obtained with power factor correction and are designed for easy installation of the G-R remote control system.

Specification, performance data and complete information may be obtained by writing Glenn-Roberts Co., 1009 Fruitvale Ave., Oakland, Calif., or 5651 W. Ohio St., Chicago, Ill.

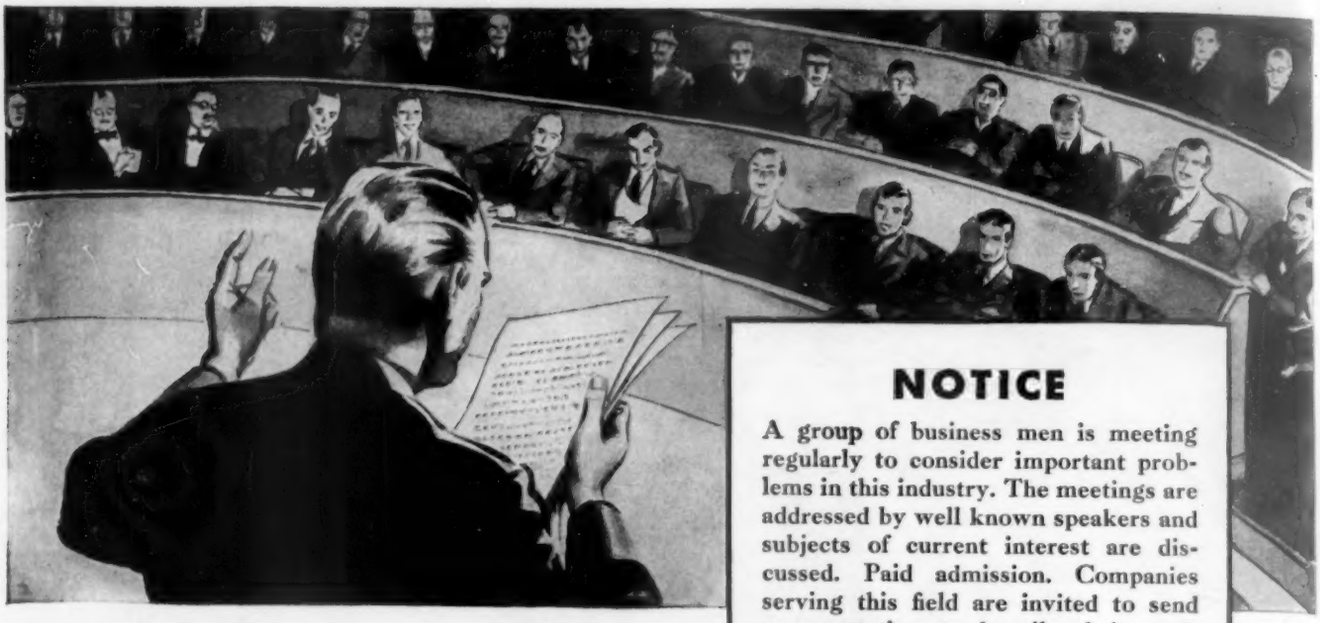
» «

Finger Guard

★ The **Industrial Gloves Co.**, Danville, Ill., announce a new finger guard known as the **Steel-Grip Finger Guard** No. 14169. This lightweight finger guard, which gives added protection to the fingers and thumbs, is made of tough leather and flexible elastic. The leather affords additional protection while the elastic keeps the guard tight on the fingers. It is available in grain leather, heavy split leather, lightweight kid leather or wool felt. The elastic feature makes Steel-Grip Finger Guards snug fitting, also flexible and porous for ventilation.



Safety for finger and thumb.



NOTICE

A group of business men is meeting regularly to consider important problems in this industry. The meetings are addressed by well known speakers and subjects of current interest are discussed. Paid admission. Companies serving this field are invited to send representatives to describe their products and services.

Such a notice might well describe the issues of this publication.

Advertisers . . . get the facts about this audience

EVERY issue of this publication reaches an influential audience which welcomes news and information about products or services for their business. In these pages you are offered an opportunity to talk to this audience.

If you were going to pay for the privilege of actually talking to an audience about your business, you would want to know all about it. How many people? What is their occupation and business? Where are they from? How much did they pay to get in? Will it pay you to talk to them?

The answer to these and many other questions would decide the value of the audience to your business.

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From an investment standpoint it is just as important that you should know *all* about the people who will see your sales message when you advertise in this or any other business paper.

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THE WELDING ENGINEER

506 S. WABASH AVE. CHICAGO, ILL.

Member of the Audit Bureau of Circulations ABC *Ask for a copy of our latest A.B.C. report*

A. B. C. = AUDIT BUREAU OF CIRCULATIONS = FACTS AS A MEASURE OF CIRCULATION VALUES

Analyses of S.A.E. Steels

Lines printed in italic represent secondary steels

Numerical designations and analyses of steels as delivered; list revised in 1941 by the Society of Automotive Engineers

Carbon Steels

S.A.E. No.	Carbon Range	Manganese Range	Phosphorus Max.	Sulphur Max.
1010	0.05-0.15	0.30-0.60	0.045	0.055
1015	0.10-0.20	0.30-0.60	0.045	0.055
X1015	0.10-0.20	0.70-1.00	0.045	0.055
1020	0.15-0.25	0.30-0.60	0.045	0.055
X1020	0.15-0.25	0.70-1.00	0.045	0.055
1025	0.20-0.30	0.30-0.60	0.045	0.055
X1025	*0.20-0.30*	*0.70-1.00*	*0.045*	*0.055*
1030	0.25-0.35	0.60-0.90	0.045	0.055
1035	0.30-0.40	0.60-0.90	0.045	0.055
1040	0.35-0.45	0.60-0.90	0.045	0.055
1045	0.40-0.50	0.60-0.90	0.045	0.055
1050	0.45-0.55	0.60-0.90	0.045	0.055
1055	0.50-0.60	0.60-0.90	0.040	0.055
1060	0.55-0.70	0.60-0.90	0.040	0.055
1065	*0.60-0.75*	*0.60-0.90*	*0.040*	*0.055*
X1065	*0.60-0.75*	*0.90-1.20*	*0.040*	*0.055*
1070	0.65-0.80	0.60-0.90	0.040	0.055
1075	0.70-0.85	0.60-0.90	0.040	0.055
1080	0.75-0.90	0.60-0.90	0.040	0.055
1085	0.80-0.95	0.60-0.90	0.040	0.055
1090	0.85-1.00	0.60-0.90	0.040	0.055
1095	0.90-1.05	0.25-0.50	0.040	0.055

Free Cutting Steels

S.A.E. No.	Carbon Range	Manganese Range	Phosphorus Range	Sulphur Range
1112	0.08-0.16	0.60-0.90	0.09-0.13	0.10-0.20
X1112	0.08-0.16	0.60-0.90	0.09-0.13	0.20-0.30
1115	0.10-0.20	0.70-1.00	0.045 max.	0.10-0.20
X1314	0.10-0.20	1.00-1.30	0.045 max.	0.10-0.20
X1315	0.10-0.20	1.30-1.60	0.045 max.	0.10-0.20
X1330	0.25-0.35	1.35-1.65	0.045 max.	0.10-0.20
X1335	0.30-0.40	1.35-1.65	0.045 max.	0.10-0.20
X1340	0.35-0.45	1.35-1.65	0.045 max.	0.10-0.20

Manganese Steels

See Note (a) for Silicon Content

No.	Carbon	Manganese	Phosphorus	Sulphur
1330	0.25-0.35	1.60-1.90	0.040 max.	0.050 max.
1335	0.30-0.40	1.60-1.90	0.040 max.	0.050 max.
1340	0.35-0.45	1.60-1.90	0.040 max.	0.050 max.
1350	*0.45-0.55*	*1.60-1.90*	*0.040 max.*	*0.050 max.*

Nickel Steels

See Notes (a) and (b) for Silicon, Phosphorus and Sulphur Content

No.	Carbon	Manganese	Nickel
2315	0.10-0.20	0.30-0.60	3.25-3.75
2330	0.25-0.35	0.50-0.80	3.25-3.75
2340	0.35-0.45	0.60-0.90	3.25-3.75
2345	0.40-0.50	0.60-0.90	3.25-3.75
2515	*0.10-0.20*	*0.30-0.60*	*4.75-5.25*

Nickel-Chromium Steels

See Notes (a) and (b) for Silicon, Phosphorus and Sulphur Content

No.	Carbon	Manganese	Nickel	Chromium
3115	*0.10-0.20*	*0.30-0.60*	*1.00-1.50*	*0.45-0.75*
3120	0.15-0.25	0.50-0.80	1.00-1.50	0.45-0.75
3130	*0.25-0.35*	*0.50-0.80*	*1.00-1.50*	*0.45-0.75*
3135	0.30-0.40	0.50-0.80	1.00-1.50	0.45-0.75
3140	0.35-0.45	0.60-0.90	1.00-1.50	0.45-0.75
X3140	0.35-0.45	0.60-0.90	1.00-1.50	0.60-0.90
3145	0.40-0.50	0.60-0.90	1.00-1.50	0.45-0.75
3150	0.45-0.55	0.60-0.90	1.00-1.50	0.45-0.75
3215	*0.10-0.20*	*0.30-0.60*	*1.50-2.00*	*0.90-1.25*
3220	*0.15-0.25*	*0.30-0.60*	*1.50-2.00*	*0.90-1.25*
3240	*0.35-0.45*	*0.30-0.60*	*1.50-2.00*	*0.90-1.25*
3245	*0.40-0.50*	*0.30-0.60*	*1.50-2.00*	*0.90-1.25*
3250	*0.45-0.55*	*0.30-0.60*	*1.50-2.00*	*0.90-1.25*
3312	max. 0.17	0.30-0.60	3.25-3.75	1.25-1.75
3415	*0.10-0.20*	*0.30-0.60*	*2.75-3.25*	*0.60-0.95*

Caution: Check with S.A.E. for possible modifications before making important commitments.

Molybdenum Steels

See Notes (a) and (b) for Silicon, Phosphorus and Sulphur Content

S.A.E. No.	Carbon	Manganese	Chromium	Nickel	Molybdenum
X4130	0.25-0.35	0.40-0.60	0.80-1.10	.....	0.15-0.25
4140	0.35-0.45	0.60-0.90	0.80-1.10	.....	0.15-0.25
4150	0.45-0.55	0.60-0.90	0.80-1.10	.....	0.15-0.25
4320	0.15-0.25	0.40-0.70	0.30-0.60	1.65-2.00	0.20-0.30
X4340	0.35-0.45	0.60-0.90	0.60-0.90	1.65-2.00	0.20-0.30
4615	0.10-0.20	0.40-0.70	.....	1.65-2.00	0.20-0.30
4620	0.15-0.25	0.40-0.70	.....	1.65-2.00	0.20-0.30
4640	0.35-0.45	0.50-0.80	.....	1.65-2.00	0.20-0.30
4815	0.10-0.20	0.40-0.60	.....	3.25-3.75	0.20-0.30
4820	0.15-0.25	0.40-0.60	.....	3.25-3.75	0.20-0.30

Chromium Steels

See Note (a) for Silicon Content

S.A.E. No.	Carbon Range	Manganese Range	Phosphorus Max.	Sulphur Max.	Chromium Range
5120	0.15-0.25	0.60-0.90	0.040	0.050	0.60-0.90
5140	0.35-0.45	0.60-0.90	0.040	0.050	0.80-1.10
5150	0.45-0.55	0.60-0.90	0.040	0.050	0.80-1.10
52100	0.95-1.10	0.20-0.50	0.030	0.035	1.20-1.50

Chromium-Vanadium Steels

See Notes (a) and (b) for Silicon, Phosphorus and Sulphur

S.A.E. No.	Carbon Range	Manganese Range	Chromium Range	—Vanadium— Minimum	Desired
6135	*0.30-0.40*	*0.60-0.90*	*0.80-1.10*	*0.15*	*0.18*
6150	0.45-0.55	0.60-0.90	0.80-1.10	0.15	0.18

Silicon-Manganese Steels

See Note (b) for Phosphorus and Sulphur

No.	Carbon	Manganese	Silicon
9250	0.45-0.55	0.60-0.90	1.80-2.20
9260	0.55-0.65	0.60-0.90	1.80-2.20

Chromium-Nickel Austenitic Steels

See Note (c) for Phosphorus and Sulphur

No.	Carbon	Manganese	Silicon Max.	Chromium	Nickel	Molybdenum
30615 (Type 1)	0.15 max.	2.00 max.	0.75	17.00-20.00	7.00-10.00	0.60 max.
30615 (Type 2)	0.15 max.	2.00 max.	0.75	17.00-20.00*	7.00-10.00	0.60 max.
30705	0.08 max.	2.50 max.	1.50	17.00 min.†	8.00 min.	.....
30805	0.10 max.	2.50 max.	0.75	16.00-18.00	10.00-14.00	2.00-3.00
30905	0.08 max.	2.00 max.	0.75	18.00-20.00	8.00-10.00	.....
30915	0.08-0.15	2.00 max.	0.75	17.00-20.00	7.00-10.00	.....

*Contains also 0.15-0.35% selenium.
†Contains 0.40% min. titanium or 0.70% min. columbium.

Stainless Chromium-Irons

See Note (d) for Phosphorus and Sulphur

No.	Carbon	Manganese	Silicon Max.	Chromium	Nickel	Molybdenum
51210	0.08-0.15	0.60 max.	0.50	11.50-13.00	.....	.....
51310	0.08-0.15	0.60 max.	0.50	11.50-13.00	1.25-2.00	.....
51335	0.25-0.40	0.60 max.	0.50	12.00-14.00	.....	.....
X51410	0.13 max.	1.20 max.	0.75	12.00-14.00	.....	0.60 max.
51710	0.12 max.	0.60 max.	0.50	16.00-18.00	.....	.....

Notes to Tables of Chemical Composition

Note (a). Silicon range of all S.A.E. basic openhearth alloy steels shall be 0.15 to 0.30%. For electric furnace alloy steels and acid openhearth alloy steels, the silicon content shall be 0.15% minimum.

Note (b). Phosphorus and sulphur in all S.A.E. nickel steels, nickel-chromium steels, molybdenum steels, chromium-vanadium steels and silicon-manganese steels shall be 0.040% max. and 0.050% max. respectively.

Note (c). Phosphorus in 30615 Type 1 is 0.04% max., in Type 2 is 0.12 to 0.17%; in the other alloys is 0.03% max. Sulphur in 30615 Type 1 is 0.18 to 0.35%, in Type 2 is 0.04% max.; in the other alloys is 0.03% max.

Note (d). Phosphorus and sulphur in all the chromium-irons except X51410 shall be 0.03% max. each. In X51410 phosphorus shall be 0.04% max.; sulphur shall be 0.18-0.35%.

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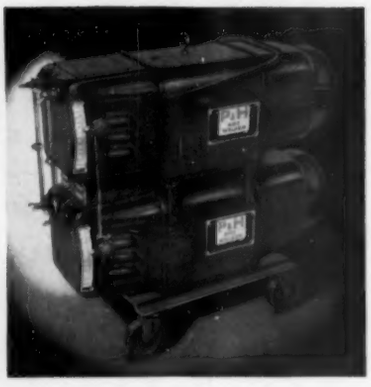
Why

Does He Get Better Welding Results?

Minimize the human element — make welding simpler — then it's easy to improve results! This is being proved every day with the simple operation and design of this advanced welding service.



P&H TYPE WD - 150
SQUARE FRAME WELDER

With but a single adjustment, you have the arc potency to suit any welding job. Arc response is automatic on all types of work. You can't mis-synchronize open circuit and arc voltage as on conventional machines.

With a welding range of from 200 down to 15 amps., the P&H Type WD-150 is small and amazingly efficient. It offers all of the recognized P&H advantages. The twin mounting, shown at right, enables you to use machines individually or in parallel to meet high amperage demands. Write for Bulletin W-28.

"HARSTAIN 18-8"
. . . An Austenitic Stainless Steel Electrode

P&H WELDING ELECTRODES

For all-position welding with short arc and low heat. Deposited metal has minimum of 18 chrome and 8 nickel to meet analysis of 18-8 stainless steel with excellent color match. Get the facts.

General Offices: 4513 West National Avenue, Milwaukee, Wisconsin

HARNISCHFEGER CORPORATION

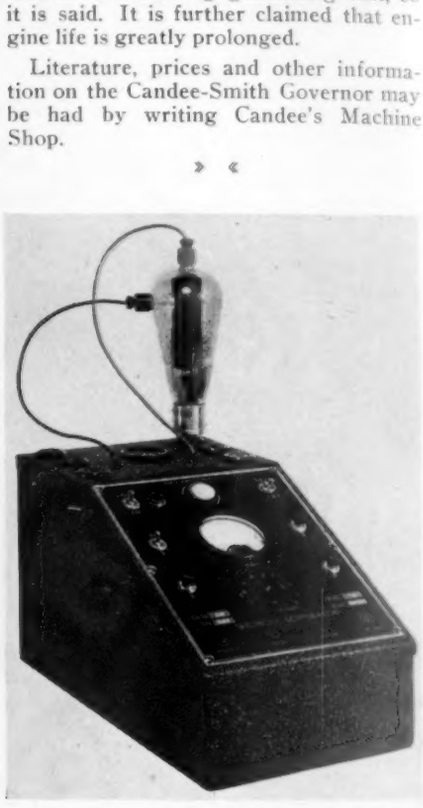
WELDING ELECTRODES • MOTORS • HOISTS P&H ELECTRIC CRANES • ARC WELDERS • EXCAVATORS

Engine Governor

★ **Candee's Machine Shop,** 129-6 Llewellyn St., Los Angeles, are offering the **Candee-Smith Governor** for the control of converted auto and truck engines used for the driving of welding generators. This compact unit, it is claimed, will accurately control and govern power output and speed of converted engines. In doing so, it makes possible the saving of fuel and a reduction in maintenance cost of the welding generating unit, so it is said. It is further claimed that engine life is greatly prolonged.

Literature, prices and other information on the Candee-Smith Governor may be had by writing Candee's Machine Shop.

» «



Universal checker incorporates cathode ray oscilloscope and milliammeter.

Tube Tester

A **Universal Tube Checker** for industrial type electronic tubes has been announced by **Weltronic Corp.,** Detroit. Provided with seven sockets, it may be used to check virtually every well-known make and type of industrial tube (except ignitrons). Special tubes may be checked through the use of socket adaptors.

The checker provides, through a one inch cathode ray tube, a visual analysis of plate current, while high vacuum tubes can also be checked with the milliammeter provided. Housed in a substantial black crackle-finish box with sloping control board, it is provided with adjustments for intensity, horizontal and vertical amplitude, and focus for the oscilloscope. It operates on 110 to 120 v., 60 c. current.

Ruggedly built, the unit is semi-portable. Its construction is said to be such as to lend itself equally well to shop and laboratory checking of tubes.

» «

The secret of patience is doing something in the meantime.

A-C Welder

★ The **Marquette 100 BB** and **200 BB** are two models of A-C Welders recently announced by the **Marquette Mfg. Co.**, Minneapolis. Designed for heavy duty operation, the Model 100 BB has an amperage range from 20 to 150, while the 200 BB ranges from 20 to 200 amps. Both models are standard for 220 volts. However, at a slight extra charge they may be obtained for operation on 440, 550 or other special voltages. For ease in moving about the shop, both models have been equipped with handles and swivel castors. Model 100 BB weighs 200 lbs. while the Marquette 200 BB weighs 235 lbs.

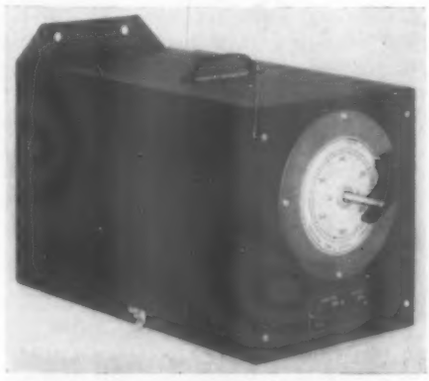
» «

This A-C welder has a range of 20 to 200 amperes.

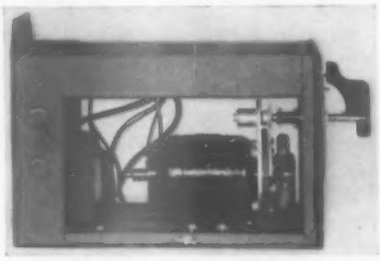
Heat Control

★ The **National Time and Signal Corp.**, 600 E. Milwaukee Ave., Detroit, announce the **Model 41 Heat Control Unit.** This heat control unit or weld current phase shifter is claimed to provide a better means for regulating welding current flow through an infinite series of graduated steps ranging from zero potential to full rated capacity. A calibrated dial provides instant finger-tip regulation. Convenient markings on the outer edge of the dial simplify setting to predetermined heat points. There are no tubes, condensers or relays. Heat changes may be made instantly without moving a wire or opening a switch.

The unit follows the design used in the many timers made by this organization and consists essentially of a synchronous ball bearing motor, two carbon brushes, a pair of wires and unique commutator.



A mechanical means for shifting the phase of weld currents.



There are very few parts in this control.

» «

Terminal Panel

★ A **Welding Terminal Panel** has been developed by **O. Z. Electrical Mfg. Co.**, Brooklyn, N. Y., particularly for use in

Welding Rods . . . not too plentiful, BUT . . .

if you need stainless electrodes for defense work, alloy and hard surfacing rods or other electrodes for special, out-of-the-ordinary applications, we can probably help you. Call the nearest Ryerson plant.

Electrodes in stock include:

McKay Stainless—7 types

Ryerson Shielded Arc — for Mild Steel and Alloys

Blue Coated — For Cast Iron

Phosphor Bronze—For Brass and Copper

Hard Surfacing Rods

Acetylene Welding Rods

●

Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Cleveland. Detroit, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON

shipyards and similar installations in connection with the Constant Potential System of Welding Feeders. The new device provides opportunities to install at any desired points, panels that intercept the main welding feeders throughout the yard, and provide facilities for the welding leads.

» «

Hard Facing Flux

★ **Krembs & Co.**, Chicago, Ill., announce a new flux for use in hard surfacing tool shanks, hammer heads, drill bits, etc., known as **Fluxine Hard Surfacing Compound.** It is claimed that when this flux is used in connection with ordinary cast iron welding rod and deposited by the electric arc process, it will produce a surface having a hardness between 68 and 72 Rockwell "C" scale. This material is also claimed to be suitable for use in tempering carbon steels, giving a more durable tool than one otherwise obtained.

News of the Industry

Purdue Welding Meeting

The 17th Annual Conference on Welding conducted by Purdue University, will be held at Lafayette, December 11th and 12th. The meeting this year has been planned to give aid to welders in the form of suggestions as to how to conduct normal business during the present emergency.

» «

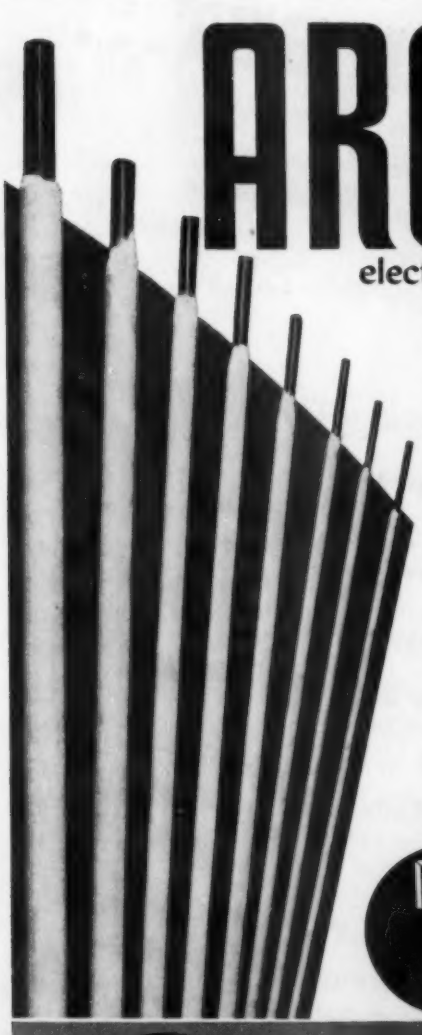
The **Jackson Products Co.**, Detroit, Mich., announce the removal of their general offices and factory to new and larger quarters at 3265 Wight St.

The **Keystone Carbon Co.**, St. Marys, Pa., announces the opening of an Eastern sales office at 249 High St., Newark, N. J. **Robert McKeown** and **Charles V. Allen** are district representatives, succeeding the late E. A. Berger, sales engineer.

The Keystone Carbon Co. also announces the appointment of **A. A. Barbera & Co.**, 417 South Hill St., Los Angeles, Cal., as representative for Keystone products in the Southern California territory.

» «

Coast Metals, Inc., Canton, Ohio, manufacturers of hard-facing material, announce the following new distributors of their products: **Joseph Wagner Mfg. Co.**, 441 Folsom St., San Francisco, will handle the Pacific Coast and Rocky Mountain States' territory; **Maryland Oxygen Co., Inc.**, 1700 S. Newkirk St., Baltimore, has been assigned the Maryland, Washington D. C. and Northern Virginia territory; **R. B. Stell** and **John Pardridge**, 254 W. 31st St., New York City, has the territory for Eastern New York, while the Western New York Territory has been assigned to **R. F. Potter**, 33 Wilkeson St., Buffalo. **Presto Battery Service**, 48 Edwards St., Hartford, Conn., will handle sales in the Connecticut territory.



ARCALOY

electrodes are available in sizes for every welding purpose

There's a complete range of Arcaloy stainless steel electrode sizes—from one-sixteenth to five-sixteenths of an inch—for every type of welding and every analysis. Welders and metallurgists alike know that Arcaloy electrodes are dependable, uniform, and meet all chemical and physical requirements—that they come to them *waterproofed* and *packed in strong wooden boxes* to assure absolute safe delivery.

Manufacturers exclusively of stainless steel electrodes of all analyses, Alloy Rods Company invites your inquiry on the correct rod for your welding job.

ARCALOY electrodes have been approved and passed by all industries—including the most stringent testing laboratories

ALLOY RODS COMPANY

Stainless Steel Electrodes

YORK, PENNSYLVANIA

Personals

The Lincoln Electric Co., Cleveland, announces the opening of a new office in Jacksonville, Fla.

J. M. Chapple, who until recently was with the Detroit Office of the Company and who for 2½ years was Managing Director of The Lincoln Electric Co. (Australia), Pty. Ltd., at Alexandria, will be in charge of the new branch.

Mr. Chapple has had wide experience in the welding industry, having been responsible, as Welding Development Engineer, for installing and developing the sales organization of the joint Armco - International - Lincoln Electric arc welding electrode factory in Buenos-Aires, Argentina. His experience includes 13 years association with the Armco International Corp., most of the time in foreign service, and training in every department of the American Rolling Mills Co., Middletown, Ohio.

The address of the Jacksonville Office for the present will be care of Union Terminal Warehouse, 700 East Union at Ionia.

The appointment of **K. E. Dinius** as chief engineer of South works of Carnegie-Illinois Steel Corp. was announced Nov. 27.

Before becoming associated with Carnegie-Illinois, Mr. Dinius was with General Electric Co., Ft. Wayne, Indiana. He came to South works in 1924 as a repairman in the electrical department and served in this capacity until 1929, when he was made testing engineer. In 1935 he became superintendent of the electrical department and a year later was transferred to the enginering department as an electrical engineer, the position he held until his present appointment.

Mr. Dinius is a graduate of Purdue University and a member of the American Institute of Electrical Engineers and the Association of Iron and Steel Engineers.

» «

C. E. Dennis has been appointed Sales Manager for the **Sellstrom Manufacturing Co.**, Chicago.

During the past three years, Mr. Dennis has been affiliated with the Sellstrom Manufacturing Company as its representative throughout the southwest and, prior to that, he was associated in a sales capacity with the Hart Welding Supply Co., Oklahoma City.

Mr. Dennis has had a wide and practical experience in the sale and merchandising of safety equipment and states that he will continue his activities in the field in addition to the executive duties of his new appointment.

» «

W. P. Childs, 845 Memorial Drive, S.E., Atlanta, Ga., has been appointed its representative in that area by **Progressive Welder Co.**, Detroit, to handle that company's line of resistance welding equipment.

» «

Walter P. Sherman, is the sales representative for the new **Arcway Equipment Co.** office recently opened at 700 E. Franklin St., in Richmond, Va. Prior to this connection Mr. Sherman was with the General Electric Co. spending six years in the Welding Engineering Department, two years in the Industrial section, and four years in customer application. Mr. Sherman is a specialist in Atomic Hydrogen welding and is also well equipped to handle any problems in arc welding.

» «

At a meeting of the Board of Directors of the Bridgeport Brass Co., November 24th, **Herman W. Steinkraus,** vice-president and a director, was elected general manager of the company. The other officers who will continue in their present capacity are **Ralph E. Day,** president, **Herbert W. Jones,** vice-president in charge of finance; **William R. Breetz,** treasurer and assistant secretary; **Rowley W. Phillips,** secretary, and **Everett Japp,** assistant treasurer.

» «

At the Annual Shareholders Meeting of the Federal Machine & Welder Co., which was held in Warren, Ohio, on November 24th, the directorate of the company was increased from three to five. In addition to the present directors, **Malcolm S. Clark, P. O. Buckley** and **E. W. Clucas,** there was added **Stewart McDonald,** former Federal Housing Administrator, and **E. E. Tross,** works manager, Youngstown District, United Engineering & Foundry Co.

» «

The following changes in the **Norton Co.** sales organization have been announced by W. R. Moore, general sales manager.

J. E. Strachan, Jr. of the Cincinnati territory has been assigned to the Pacific Northwest where he replaces **A. M. Pitts** who resigned on October 1. **S. F. Prescott,** Worcester sales engineering department becomes salesman for the Cincinnati territory, **J. P. Enright,** formerly in the Chicago office, becomes field engineer for the Chicago district. **Wendell C. Forsman,** sales engineering department, Worcester has been appointed field engineer for Detroit and vicinity.

» «

Even Welders Unfamiliar with

Get Deposits FREE From Porosity!

Yes, even a welder without previous experience with Ampco-Trode can now get sound deposits, for this aluminum bronze rod has an improved coating, which assures satisfactory welding by all three methods.

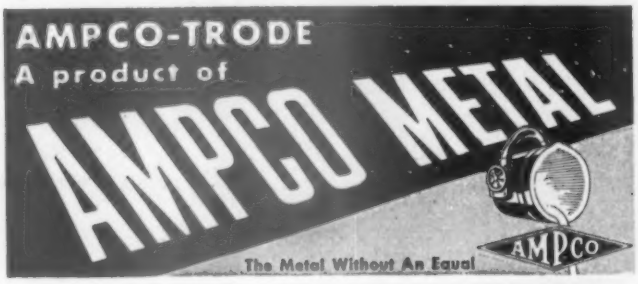
And, in addition, much smoother arc action results—better adhesion, more easily removed slag, and less spatter.

Ampco-Trode is made to the analysis of AMPCO METAL and has its high physical properties, stubborn resistance to wear on sliding surfaces, great strength and durability. It is outstanding for overlaying steel and cast iron, building up shafts, wear strips, valve seats, and building up large forming and drawing dies. It is suitable for use with metallic arc, carbon arc, and oxy-acetylene welding.

AMPCO METAL, INC. *Dept. W.R. 12* **MILWAUKEE, WIS.**

NEW BULLETIN

Describes Ampco-Trode and how to use it. It is well-illustrated with photographs of welds and X-Rays, charts, and diagrams. Free to welding engineers.



Will you save a life?

NOT many of us can be spectacular heroes. Yet by buying Christmas Seals you save human life just as surely as if you had plunged into a burning building!

More people between the ages of 15 and 45 die from tuberculosis than from any other one disease. By using Christmas Seals you make possible a year-round campaign against this pestilence—a campaign that since 1907 has reduced the tuberculosis death rate 75%!

Help save more lives in 1942!

Buy CHRISTMAS SEALS

The National, State and Local Tuberculosis Associations in the United States

E. P. Auler, welding engineer, Taylor Forge & Pipe Works, R. L. Kohlbry, vice-president, Machinery & Welder Corp., and T. B. Jefferson, editor, *The Welding Engineer*, formed a trio of welding experts who took part in a radio forum over WCFL on November 23rd. This forum, which is known as "Your Job in Review" is designed primarily to give job counseling advice to those seeking work in industry. This is the first time that welding has been discussed from this angle on the air.

Obituary

John L. Taylor, Contracting Manager of the Barge Dept., American Bridge Co., died Oct. 24, in Pittsburgh, Pa., after an illness of several months. Mr. Taylor was born in Three Rivers, Mich., July 28, 1877.

Mr. Taylor was an outstanding authority on the design and construction of steel barges of all types for use in inland waterways and harbors. He designed and supervised the construction of the first all-welded steel barge, and pioneered in a large number of improvements and special features of barge construction which today are accepted as standards for their respective kinds of service. During World War I, he conceived the idea and, by his efforts and ingenuity, effected the methods used for pre-fabricating ship steel at inland plants for final and complete assembly at various shipyards.

Construction

H. C. Price Co., Bartlesville, has been awarded contracts for electric welding of the following pipe lines:

For **Natural Gas Pipeline Co.** of America—88 Miles of 26-inch in Iowa —General Contractor W. A. Bechtel Co.

For **Hope Natural Gas Co.**—45 Miles of 12-inch from Ripley, West Virginia to Waverly, West Virginia—General Contractor Ligon & Ligon.

For **Standard Oil of Ohio**—10 Miles of 12-inch loops in Illinois—General Contractor Sheehan Pipe Line Construction Company.

For **American Rolling Mills**—9 Miles of 16-inch near Middletown, Ohio.

For **Illinois Pipe Line Co.**—12 Miles of 8-inch near Bridgeport, Illinois — General Contractor Sheehan Pipe Line Construction Company.

For **Panhandle Eastern Pipe Line Co.**—45 Miles of 8-inch from Galesburg, Illinois to Peoria, Illinois—General Contractor Oil States Construction Company.

For **Illinois Pipe Line Co.**—6 Miles of 6-inch near Wood River, Illinois—General Contractor Sheehan Pipe Line Construction Company.

For **Rock Island Pipe Line Co.**—2 Miles of 8-inch near Zionsville, Indiana — General Contractor Sheehan Pipe Line Construction Company.

For **Frontier Fuel Oil Corp.** and New York Transit Company — 21 Miles of 6-inch and 8-inch near Buffalo, New York—General Contractor Sheehan Pipe Line Construction Company.

For **Mountain Fuel Supply Co.**—32 Miles of 18-inch from LeRoy, Wyoming to near Little America, Wyoming — General Contractor Sheehan Pipe Line Construction Company.

Current Reviews

Shipbuilding

The Labor Division, Office of Production Management, today issued a 22-page pamphlet, **"Ships for Freedom,"** telling how, with the cooperation of workers, management and government, an industry-wide program has been

TITAN—the Users' Assurance of Perfect Welding Results.

Trade Mark Registered

TITAN BRONZE WELDING ALLOYS

—preferred by experienced welders from coast to coast — are the result of many years of TITAN pioneering.

DOUBLE DEOXIDATION, developed by TITAN metallurgists, eliminates injurious gases and assures *increased ductility plus greater strength* in the weld deposit.

Our production facilities are being used to their utmost capacity to make available Titan products necessary to the Defense Program. We regret that these requirements are currently in such volume that until this program is completed it will be impossible to fill the requirements of new customers unless they bear a priority rating.

Send for newly-issued folder describing TITAN Alloys. No obligation.

TITAN METAL MANUFACTURING CO.
Bellefonte, Pennsylvania

developed to bring labor stability to the shipbuilding industry.

The pamphlet, which contains a foreword by Sidney Hillman, Associate Director of the OPM, reviews the organization and work of the Shipbuilding Stabilization Committee and contains a summary of wage and other working agreements made throughout the industry.

Copies of "Ships for Freedom" may be obtained from the Division of Information, **Office for Emergency Management,** Social Security Building, Washington, D. C.

» «

Operator Training

An 88-page booklet has just been published to help instructors in plants and vocational schools set up courses of training for welding and cutting operators, and inspectors. Subject matter which should be covered, and suggestions for organizing the courses into a series of lessons which include a lecture, outside study, demonstrations, and practice exercises are described in this booklet, **"Training of Oxy-Acetylene Welding and Cutting Operators,"** published by the International Acetylene Association. Copies can be obtained by writing the Secretary, **International Acetylene Association,** 30 East 42nd St., New York, N. Y. The price for a paper-bound copy is 25 cents; for a deluxe edition, imitation-leather-bound, 75 cents.

» «

Electric Motor Folder

Small motors from ⅛ to ½ horsepower, 145 frame size, for general use are described in a new eight-page folder announced by Westinghouse Electric and Manufacturing Co. The standard parts making available more than 5000 combinations of type, rating, and mounting are described and illustrated. Charts show motor characteristics plotting per cent synchronous speed against per cent full load torque.

Features conducive to long motor life and low maintenance are discussed along with construction details. Thermoguard protection against overloads and excessive temperature is explained. Blackline drawings give the necessary physical and mounting dimensions. A copy of folder **F-8623** may be secured from department 7-N-20, **Westinghouse Electric and Manufacturing Co.,** East Pittsburgh, Pa.

» «

Steel Plate Data

The **American Iron & Steel Institute,** 350 Fifth Ave., New York, has released a revised edition of Section 6, **Carbon Steel Plates,** of the Steel Production Manual. In this edition, the reader is brought up-to-date with respect to various A.S.T.M. specifications that apply to carbon steel plates. In addition, there is given information regarding definitions and classifications of steel plates, rules to be observed in ordering, permissible variations in sizes and chemical composition, as well as a glossary of steel mill terminology in connection with the production of carbon steel plates. Cost is 25 cents, postpaid.

» «

Design Booklet

The **American Institute of Steel Construction,** New York, recently issued a 12 page booklet entitled **"Bridge Railings, Their Design and Construction."** This booklet will be of particular interest to the welding industry because it contains many drawings of bridge railings of welded construction. Copies of this booklet may be had by addressing a request to the Institute.

» «

Grinding Booklet

The **Norton Co.,** Worcester, Mass., have released a new 32 page booklet entitled **"What, Why and How About Grinding Machines?".** This book is intended primarily for apprentice, trained or technical school students and the many new operators of grinding machines. In order to keep it as condensed as possible, most of the material deals with grinding or grinding machines in general. Such information, however, is so fundamental that it is applicable to most any kind of precision grinding. When details have been given, they

DO YOU KNOW

WHY "MAJOR" RUBBER COVERED SUPER-FLEXIBLE WELDING CABLE SELLS SO FAST.....?

You can boil the answer down to 3 words: . . . **MOST FOR LEAST**

"MAJOR" RUBBER COVERED SUPER-FLEXIBLE WELDING CABLE is a "SAFE-WELD" product, made by a million dollar manufacturer. It is tough, durable, waterproof, extremely flexible and has high tensile strength and maximum abrasion resistance. Compares with the best and costs the least—that's why you should ask about it before you order ANY welding cable. Made in sizes #6 to #4/0 with capacity from 75 to 550 amps.

Write A. H. Friese, President

WELDING ENGINEERING CO.

MILWAUKEE, WISCONSIN

cover the principle adjustments of the machine in use. The book, which is primarily of the questions and answers type, gives most of the essentials regarding grinding. In addition, it is highly illustrated, showing the types of machines and their various lubrication systems.

» «

Welding Supply Catalog

The **Chicago Welding Sales Co.**, 3611 Ogden Ave., Chicago, have released a new 20 page catalog of Welding and Cutting apparatus, and supplies.

Aided by a complete index, the reader will find the entire line of welding equipment and supplies which are available from the Chicago Welding Sales Co. In addition to a number of illustrations, there is a complete description of the various types of fluxes, tinning compounds, welding rods and the electrodes which are sold by this company, as well as highly descriptive information regarding safety equipment, welding machines and electrode cable.

» «

Electrode Bulletin

The **Arcos Corp.**, Philadelphia, has just published Arcos **Technical Bulletin No. 5** on the welding of stainless steel. In this 12 page booklet there is given tables showing current values, weld metal characteristics, deposition data, heat treatment, and the application of Arcos stainless and alloy electrodes.

» «

Welding Booklet

Vest Pocket **Checking Pad For Cutting Costs, Speeding Work, Improving Quality, Increasing Profits by Arc Welding.** 40 pages. Pictorially and editorially questions reader about 23 typical arc welding applications for possible use and benefit by manufacturers. **May be** obtained free of charge from **Hobart Brothers Co.**, Troy, Ohio.

» «

Heat Treating Film

The Lindberg Steel Treating Co., Chicago, have prepared a sound color movie entitled **"Heat Treating Hints"** for heat treater training in educational purposes. This film, which is approximately 40 minutes in length, covers such subjects as straightening methods, torch spotting, straightening from quench, draw straightening, tongs, tools and tricks to help avoid distortion in the handling of high speed steel.

A descriptive pamphlet has been prepared, giving complete details on the heat treating hints movie. It tells how to make arrangements for showings at plant or society meetings. Copies can be had by writing the **Lindberg Engineering Co.**, 2450 W. Hubbard St., Chicago.

» «

Electrode Booklet

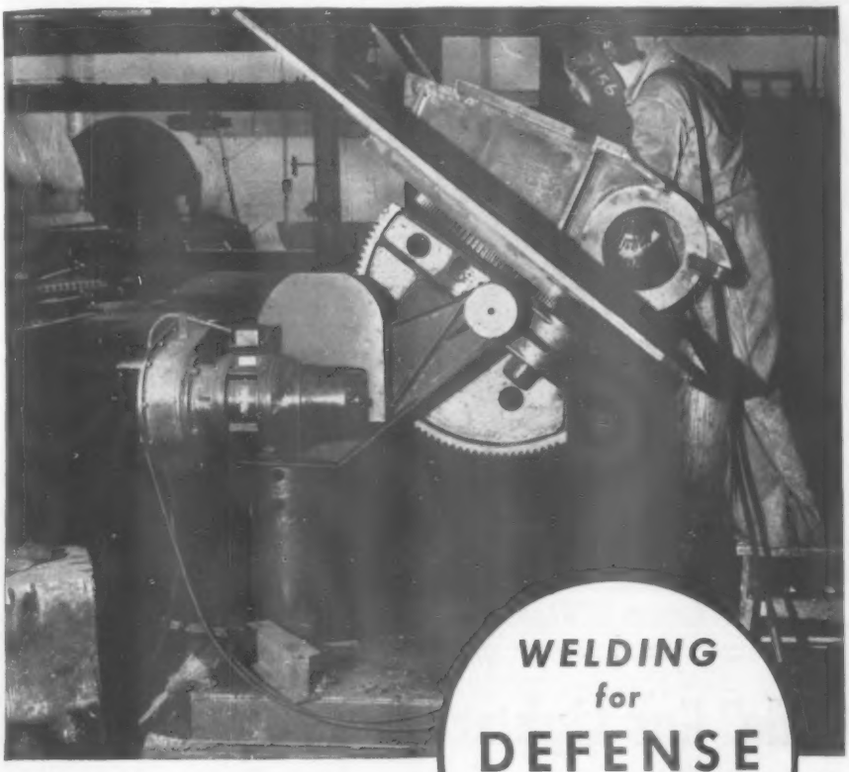
Ampco-Trode is the title of a new 6 page booklet on coated aluminum bronze welding rod recently released by the **Ampco Metal Co., Inc.**, Milwaukee. In this booklet will be found information regarding these aluminum bronze rods, their several grades and ranges of property and how they may be used in arc or oxy-acetylene welding. Technical information of value to every engineer is detailed and every opportunity is sought to make this booklet a valuable treatise on the use of aluminum bronze rods.

» «

OEM Handbook

The Office for Emergency Management announced publication of a 72 page handbook detailing the functions and administration of the various defense agencies within or associated with the OEM.

Designed for general reference, the handbook briefly outlines the development of the defense agencies, explains the authority under which each agency was created, describes its functions, and lists its staff. It also contains charts showing the entire national defense organization as well as the organization of the Office of Production Management, the Office of Price Administration, and the Office of Civilian Defense. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of 10 cents.



WELDING for DEFENSE on C-F WELDING POSITIONERS ★

★ This C-F Positioner on the production line at the Manitowoc Ship Building Co.'s plant provides all "down-hand" welding faster and safer on defense work.

★ Time is the element here, where defense work is at high speed. Many C-F Positioners are at work saving time and labor, reducing accident hazards and, more important, providing better "down-hand" welding at all points of assemblies which would otherwise take twice as long to handle and position for welding. After the work is fastened to the table of a C-F Positioner, the welder can tilt it, turn it around 360 with a choice of speeds. You should have the complete story about C-F Positioners which is given in our circular W P 20. We will gladly send you one upon request.

CULLEN-FRIESTEDT CO.,
1309 S. KILBOURN AVE. CHICAGO, ILLINOIS

Positioner Bulletin

A twelve page bulletin No. 200 profusely illustrated and fully describing the **Ransome Welding Positioner** line, has been published by the Industrial Div., **Ransome Concrete Machinery Co.**, Dunellen, N. J.

Many national defense items are illustrated demonstrating the desirability of position welding in the interest of increased production and lowered costs. Positioners range in capacity from 2,500 lb. hand-operated to 8 ton heavy-duty motor operated. Complete details and dimensional drawings are included.

» «

Steel Specifications

"Simplification of Structural Steel Shapes" is the title of a new 4 page booklet released by the American Iron & Steel Institute, New York City. This booklet lists the simplified sections that will be available to the users of steel shapes after February 1st, 1942. It is in accordance with the orders issued by the Office of Production Management, October 22nd, 1941. Those interested may obtain a copy of this pamphlet from the **American Iron & Steel Institute**, 350 Fifth Ave., New York, for 25 cents, postpaid.

» «

APPLICATOR BARS

APPLICATOR BARS are available in ROUND, SQUARE, FLAT, SPECIAL SHAPES

Recommended where deposition of large amounts of metal is required, such as Jaw Crushers, Mantles, R. R. Crossings, Gold Dredge Bucket Lips, Tumblers, etc.

Write for name of nearest distributor.

"Aid National Defense: Save Steel by Welding."

Don't Scrap Worn Equipment—*Repair* with MANGANAL

STULZ-SICKLES CO. SOLE PRODUCERS **91 N. J. Railroad Avenue, NEWARK, N. J.**

The Improved "Round File" Gas Lighter

Most Economical

Unrivalled economy is provided by the many superior, exclusive design and construction features of the Improved "Round File" lighter.

A large file area is provided — approximately one square inch. The file is of superior quality, hardened in our own factory. The spark metal is of large diameter and the patented cartridge holding the metal locks exactly into position, permitting instant replacement. The lighters are cadmium plated, rustproof. Every part thoroughly tested.

Circular and prices on request

SAFETY GAS LIGHTER CO. (Est. 1901) **LYNN, MASS.**

Wrought Steel Wheels

"Wrought Steel Wheels" is the title of Section 20 of the Steel Production Manual issued by the **American Iron & Steel Institute,** 350 Fifth Ave., New York. This is a revision of this section which was previously issued in March, 1938. In this booklet, information is given regarding the manufacture, heat treatment, standard manufacturing practices, machining, selection of wheels in relation to service conditions, and permissible wheel loads. In addition there is given engineering information regarding the common types of failures experienced in railroad wheels, computation of tread stresses, Association of American Railroad Specifications for various types of wrought steel wheels.

Copies of this manual may be obtained from the Iron & Steel Institute at a cost of 25 cents postpaid.

» «

Steel Comparison Booklet

A pamphlet published by Joseph T. Ryerson & Son, Inc., compares the two systems of steel identification (SAE, the Society of Automotive Engineers, Inc.; and AISI, the American Iron and Steel Institute).

This booklet contains all the latest official data for both of these new systems of identification. Direct comparisons of the equivalent or alternate steels are given in quick tabular form. The SAE and AISI systems are explained. Complete analyses ranges for straight carbon and alloy steels of both systems are listed, and the average physical properties of AISI and SAE steels are given in their proper relationship.

Copies may be obtained from **Ryerson Steel-Service** plants in Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, and Jersey City.

» «

Defense Booklet

"BLACKOUTS," a comprehensive 60-page pamphlet prepared by the War Department, was recently issued by the **Office of Civilian Defense.** The first chapter, "Planning the Blackout," describes the purpose, scope, definitions, training and procedure, action after blackouts and basic considerations in planning blackouts. The second chapter, "Obscuration Methods and Materials," describes the treatment of glazed surfaces, the use of paint, adhesive treatments on glass, etc. The third chapter, "Individual Persons and Dwellings," offers advice to the individual, describes blackout equipment for street use, and conduct during an air raid. Chapter four, "Stores, Factories, and Industrial Buildings," deals with maintenance of essential services, emergency communications, industrial light control, and ventilation. Chapter five, "Utilities, Municipal Services, and Installations," covers utilities and municipal services, electric light and power. The final chapter, "Transportation," covers motor transportation, the use of luminous materials, illuminated signs, traffic light signals, route numbers and direction signs,

safety zones and obstructions and motor vehicle blackout devices.

It is being distributed by the Office of Civilian Defense to the governors of the states and local defense councils through the State Defense Councils. It is available for 25c from the Superintendent of Documents, Washington, D. C.

Recent Patents

Spot Welding

2,261,714. **Harry R. Canfield,** Cleveland, Ohio, assigned to The **Clark Controller Co.,** Cleveland, O. Filed Feb. 20, 1939. Issued Nov. 4, 1941. Fluid pressure actuated electrode welding devices are controlled by means of a novel system. The system includes a source of electric current, an expansible fluid pressure chamber having a pressure movable wall, a source of fluid pressure and a fluid pressure supply conduit communicating with the pressure source and the chamber to supply fluid pressure to the chamber at an unretarded rate, to effect a quick initial unretarded movement of the wall. There is also included an electric contactor including contacts, the contacts being closed by the movement of the pressure wall. That same movement also operates a valve unit to throttle the rate of fluid pressure supplied to the chamber to effect subsequent retarded movement of the movable wall. The retarded movement effects opening of the contacts at a predetermined time.

» «

Electrode

2,260,866. **Raymond E. Powell,** Westfield, N. J., assigned to **Western Electric Co.,** New York, N. Y. Filed May 10, 1940. Issued Oct. 28, 1941. An electrode for a resistance welding apparatus and adapted to simultaneously transmit mechanical welding pressure and electrical current. The electrode includes three metallic members in sequence. Each member is linked to the next to have pivotal freedom of motion, the links serving to transmit welding pressure and welding current. The links are at right angles to each other to permit movement in two directions.

» «

Welding Screens

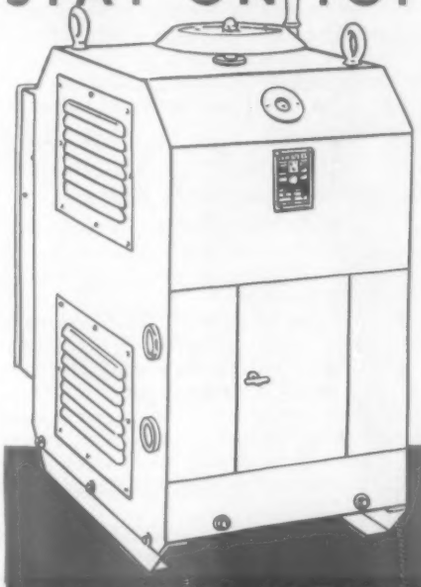
2,260,928. **Kenneth R. Bixby,** Canton, Ill. Filed June 3, 1940. Issued Oct. 28, 1941. This invention is designed primarily for welding the rods of a screen to the supporting bars. The apparatus includes electrodes arranged to receive between them the supporting bars and the rod to be welded thereto, one of the electrodes being normally stationary and the other electrode being movable toward and from the stationary electrode. A feeding device is supported above the stationary electrode. The movable electrode and the feeding device are moved in timed relation to bring an unwelded element into welding position and to effect the welding operation.

» «

Welder Control

2,261,664. **Charles H. Rippl,** Cleveland, Ohio, assigned to The **Clark Controller Co.,** Cleveland, O. Filed Oct. 21, 1938. Issued Nov. 4, 1941. A control for fluid pressure actuated electrode welders is described in this patent. The control causes the electrodes to remain in pressure engagement with the work for a predetermined time interval after the welding current is interrupted. The frequency at which successive welds may be made is timed, or a predetermined delay between successive welds may be made. Provision is made to insure that the electrodes will have been released from the work and again engaged with the work before a succeeding impulse of welding current occurs. The timed period during which the electrodes remain engaged

STAY ON TOP *with* **G-R**



When the work's piled high and time grows short, you'll bless the day you put G-R's on your job... for you *know* you're getting the *most welding* out of every hour, every kilowatt of power.

Perfect heat control, no magnetic blow and satisfactory work at higher amperages means faster welding, less spoilage and higher production ...*plus* lower costs because G-R efficiency is high!

If you haven't put G-R's on your job, check now to see which model (from 125 to 2,000 amps, for manual, automatic and Unionmelt) you need.... WRITE, WIRE OR PHONE:

Shown here: new G-R Model 45, 100-625 amp range, for manual or automatic welding. It's a honey! Power Factor Corrected.

GLENN-ROBERTS COMPANY

1089 FRUITVALE AVENUE, OAKLAND, CALIF. CHICAGO: 5651 W. OHIO STREET

The Improved **SIMPLEX** Electrode Holders

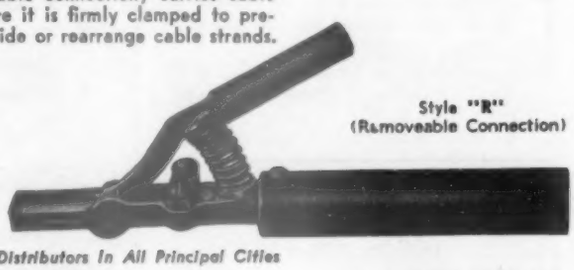
Practical—Economical—Light

WEIGHT 15 OZ. EACH 1/16" to 1/4" ELECTRODES

STYLE "S" (Soldered Connection)

Jaws of heavy copper alloy of sufficient current capacity and strength to withstand duties of its class. Sturdy compression spring supported by heat resisting insulating seats. Current can not pass through spring. Insulating fibre handle permits firm balanced grip. STYLE "S" (Soldered connection) has rear end of fixed jaw cored to receive cable, insulating handle covers connection. STYLE "R" (removeable connection) carries cable to a point ahead of handle where it is firmly clamped to prevent heating. Unnecessary to divide or rearrange cable strands.

Send for large, profusely-illustrated Catalog No. 20.



Style "R" (Removeable Connection)

Distributors In All Principal Cities

THE FIBRE-METAL PRODUCTS CO. CHESTER, PENNA.

with the work after the welding current ceases to flow and the timed period of delay or frequency between successive welds may be adjusted one independently of the other.

» «

End Welder

2,260,969. **John D. Crecca,** U. S. Navy, **Samuel S. Scott,** St. Albans, N. Y., and **Albert M. Candy,** La Grange, Ill. Filed Sept. 4, 1940. Issued Oct. 28, 1941. For end welding bolts, studs, etc., to metal members such as steel plates, a device is used for timing the duration of the welding arc and for automatically moving the piece to be welded into weld relation with the member forming the other electrode.

» «

Electrode Holder

2,261,373. **Norman J. Hoenie** and **Frank Malner,** Cleveland, Ohio, assigned to The **Lincoln Electric Co.,** Cleveland, O. Filed July 11, 1938. Issued Nov. 4, 1941. In an electrode holder, a base member and a lever member angularly movable in relation to each other, and jaws carried by these two members, the jaws being electrically insulated from the two members.

» «

Electric Welding

2,260,775. **Theodore N. Fritzsch.** Johnstown, Pa. Filed Jan. 3, 1931. Issued Oct. 28, 1941. This patent describes a process which involves supporting a welding wire in parallel spaced relation to the metal to receive the weld. The wire is insulated from contact with the metal by means of paper rings around the wire. The wire and metal are covered with a welding flux that is electrically non-conductive when cold and which is a high-resistance conductor when hot. A localized portion of the flux is heated to cause it to become electrically a high-resistance conductor at that portion, and an electric current is passed through the welding wire and the base metal to effect welding. The flux is progressively heated by thermal conduction from contact with the welding wire. The heat causes the flux to gradually become a high-resistance conductor through which proportionate portions of the current pass to effect progressive and gradual preheating of the metal in advance of the welding action.

» «

Welding Wide Sheets

2,261,694. **Walter Meenen,** Berlin, Germany, assigned to **Westinghouse Elec. & Mfg. Co.,** Pittsburgh, Pa. Filed Aug. 2, 1940. Issued Nov. 4, 1941. In the welding together of wide sheets of metal of relatively long length it may be difficult to produce a weld that is sound and fully reliable over the entire width of the strip. In the course of producing such a weld in the usual manner the steel strip enters more and more during the welding process the region bounded by the supporting arms that carry the electrode members. As a consequence, the inductance of the welding circuit changes, causing a decrease in the amount of power supplied to the weld. This has a harmful effect on the nature of the weld in the end portion of the strip weld. The invention provides for joining relatively wide strips of steel or the like by passing the strips between a plurality of pairs of electrode members positioned substantially along the line of the weld between the strips in predetermined spacial relation and simultaneously producing aligned welds by passing electric currents through at least two pairs of the electrode members and the strips in series circuit relation. A large number of aligned seam welds are simultaneously produced in end-to-end relation.

» «

Well Pipe Joint

2,259,232. **Albert L. Stone,** Palos Verdes Estates, Calif., assigned to **Hydril Co.,** Los Angeles, Calif. Filed Aug. 17, 1938. Issued Oct. 14, 1941. In a break joint for well pipe, a built-up joint member embodying a tubular box element having an internal coupling thread extending inward from one end and having an outer, unthreaded portion which is of greater diameter than the thread. A sheathing of appreciable thickness and of wear-resistant metal is situated about the unthreaded portion and is weld-integrated with the box element only at spaced locations so as to prevent separation of the element and the sheathing when they are subjected to high tensile and torsional loads.

» «

Half-Wave Spot Welding

2,259,289. **Wilhelm Blumentritt,** Berlin, Germany, assigned to **Westinghouse Electric & Mfg. Co.,** Pittsburgh, Pa. Filed May 21, 1938. Issued Oct. 14, 1941. This patent relates to an improvement of a spot welding device in which the welding circuit is connected to an alternating current potential source through a single anode grid controlled or vapor discharge vessel, and in which, after the closing of an auxiliary switch starting the welding process, the grid potential of the discharge vessel is varied in such manner

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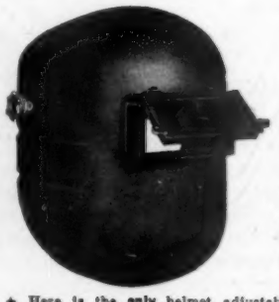

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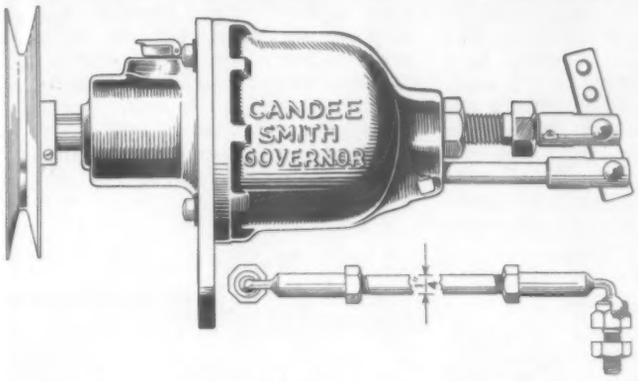

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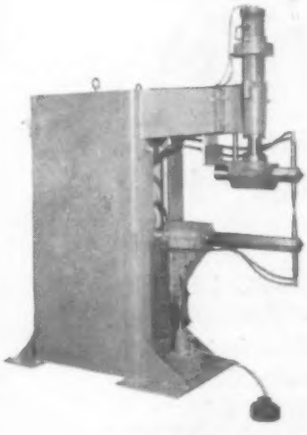

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that, at most, a discharge persisting for a half wave of the feeding alternating current source, is released.

» «

Pressure Vessels

2,259,976. **Cecil D. Howard,** Swarthmore, Pa., assigned to **Sun Shipbuilding & Dry Dock Co.,** Chester, Pa. Filed July 7, 1938. Issued Oct. 21, 1941. The inventor points out that it has been the practice in the construction of tanks, pressure vessels, and the like, to form a series of rings, weld them together and then to weld on a head or heads. The practice involved forming the rings from suitable metal, and then they were welded internally and externally along their longitudinal and girth seams. The external welding has been accomplished mechanically. The object of this invention is to accomplish the mechanical internal welding of the longitudinal and girth seams. The apparatus includes a rail, a carriage on the rail, an arm extending from the carriage in a direction longitudinally of the rail, a welding head supported from that arm for longitudinal and pivotal movement and a guide wheel pivotally associated with the welding head. The wheel is capable of being locked in any one of a plurality of positions about its pivot.

» «

Seam Welding

2,260,260. **Martin A. Mikesh,** Lawrenceville, N. J., assigned to The **M. W. Kellogg Co.,** New York, N. Y. Filed July 25, 1940. Issued Oct. 21, 1941. An apparatus is described which is particularly adapted for welding in the interior of elongated tubular articles. The device deposits inside beads in tubular articles by flux submerged arc welding. The welding is controlled and actuated at a point removed from the welding zone, which permits the elements of the apparatus that enter the article during welding to be reduced to a minimum number. Suitable motor drives and guiding channels are employed to obtain proper correlation of the electrode wire and the seam to be welded.

» «

Multiflame Tip

2,260,342. **Marvin R. Scott,** Cleveland, Ohio, assigned to **Oxweld Acetylene Co.,** of West Virginia. Filed June 28, 1939. Issued Oct. 28, 1941. The main object of this invention is to provide an improved multi-flame tip for position welding ferrous metal pipe parts the ends of which have surfaces arranged to form a circumferential welding groove, such as a V. The tip includes a main metal unit having a central cylindrical gas chamber terminating in an inner surface of conical shape. A rod preheating jet passage extends from one side of the conical surface and a main welding jet passage extends from the other side of the conical surface. These two passages form an angle of about 20 degrees with their outer ends spaced about $\frac{7}{16}$ inch from each other. The tip also includes a pair of work preheating gas passages which are located below the other two passages. The work preheating passages are spaced at their outer ends about ¼ inch from each other, and there is an angle of about 45 degrees between the work preheating passages and the welding gas passage, with a spacing between their outer ends of about $\frac{5}{8}$ inch. The use of this tip has shown an increase in welding speed of 31 to 65 per cent over the conventional single flame tip for position welding.

» «

Welder Control

2,260,405. **Frank H. Roby,** Milwaukee, Wis., assigned to **Square D. Co.,** Detroit, Mich. Filed Nov. 3, 1937. Issued Oct. 28, 1941. The method of electrically welding material by passing current through the material between electrodes pressed against the material which comprises initiating the electrode pressure, closing one set of cooperating contacts in the circuit to the electrode while maintaining the circuit open at a second set of contacts, and closing the second set of contacts a predetermined time after the start of pressure on the first set and substantially at a predetermined point on the supply wave. The first set of contacts is opened a predetermined time after the second set is closed and substantially at a point when the welding current has an instantaneous value of zero.

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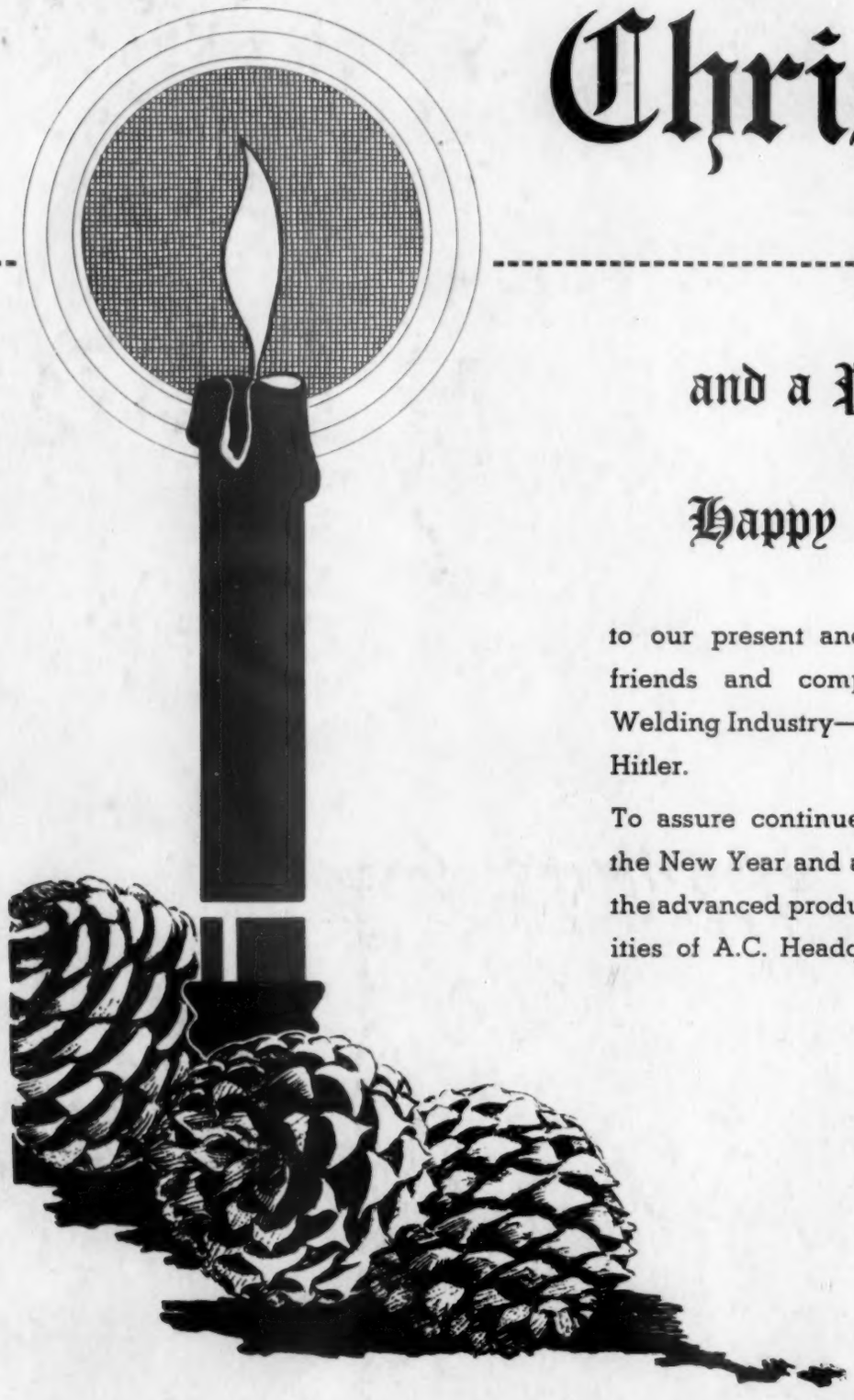

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